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*THE RELATION OF EDUCATED MEN TO THE STATE.**

I SHOULD fail to do justice to my own feeling did I not pause for one moment to acknowledge the kindly greeting which has just been extended to me at the beginning of my life among you. For the words of encouragement which have been spoken, for the assurance of cooperation and support, for the cordial personal welcome, I am more grateful than I can say. The response to such words and to such welcome is not to be made at this time and at this place. It can be given only in the years of service which lie before us.

In choosing a subject upon which I might address you to-day, I have felt strongly influenced to call to your attention certain conclusions which touch upon that great interest which is the common bond which brings us together to-day—the education of men.

It was my fortune some years ago to pass from a university place to that of an executive office of the general government; to go from the work of training students to a corps of men who are recruited almost wholly from the ranks of college graduates. In the attempt to secure for the government service men of the best training, the relation

* Inaugural Address of Dr. H. S. Pritchett, late Superintendent of the U. S. Coast and Geodetic Survey, as President of the Massachusetts Institute of Technology.

of the educated man to the government, whether as an employe or as a citizen, has been a matter of immediate practical consideration.

In such a position one studies the output, if one may use that term, of our universities and of our colleges from a different point of view from that which the teacher occupies. He is measuring the college man in comparison with other men, from the standpoint of his ability to do things and not from the standpoint of the knowing how to do things.

The two points of view are very different, and it is for this reason, as well as for the strong interest which I have in the subject, that I have deemed it not entirely without interest to say a word to you at this time concerning higher education in relation to the government, and more particularly to consider the part which educated men are to-day taking, and ought to take, in government, the obligations of the higher institutions of learning to the State, and finally to discuss briefly the question whether these obligations are being fairly and honestly and intelligently met.

There is a saying which is current in the student talk of German universities to the effect that of those who enter the university doors one-third breaks down, and one-third goes to the devil, but that the remaining third governs Europe. Such expressions are oftentimes more apt than true; yet, on the other hand, they sometimes represent popular conviction more correctly than formal tables of statistics, just as a bit of floating straw shows the direction of the current more truthfully than the powerful cruiser.

Unfortunately, it is not easy to subject such a statement to accurate examination. The statistics of the unsuccessful are necessarily far more incomplete than the statistics of those who attain prominence. The devil keeps no books, so far as I know; or if he does, they are not open to examination of the student. But it requires only a limited study to show that the last part of the statement is certainly true, at least so far as Germany is concerned. The educated man, trained in either the university or polytechnicum, governs Europe to-day.

No one connected with the government of the United States in any executive capacity can fail to see that the government of this country is also passing rapidly into the hands of educated men. The population of the country at this time is approximately 76,000,000 of people. The number of college trained men is perhaps less than one per cent. of the population. From this small percentage, however, are filled a majority of the legislative, executive and judicial places of the general government which have to do in any large way with shaping the policy and determining the character of the government.

Not only in the ordinary positions of the government service is this true, but the government is calling more and more frequently upon the educated man for the expert service for which his training is supposed to fit him, and this not only in the relation of scientific experts, but in all other directions in which the government seeks the advice and the assistance of trained men.

On the other side of the Pacific a commission of five American citizens has undertaken the most delicate, the most difficult, doubtless the most thankless task in the establishment of civil government to which any group of our citizens has ever devoted its unselfish efforts. It is a significant fact that a majority of that commission are college professors.

In the service of the government, as in all other fields where intelligence and skill are factors, the educated man is displacing from the higher places the one who has no training or who has a poor training. Whether wisely or unwisely, whether for

good or ill, it may be accepted as a fact that the government of this country is passing rapidly into the hands of the educated man.

It is a matter of the highest practical importance to inquire whether the man who is coming into this power is worthy of it, and whether the training which he has received in the college or in the technical school is given with any purpose of fitting him for this trust.

Before approaching this question it may be well to call to mind the attitude of the government of the United States and of the State governments toward higher education and toward scientific investigation.

Notwithstanding the crudeness of our legislation, it is still a fact that Congress and the State governments of the United States have been generous in gifts to higher education and to scientific work. The gifts of the general government have come from the sale of public lands; to the separate States has been left, heretofore, the power to lay taxes for the support of institutions of higher training.

It is difficult to bring together the data for a trustworthy statement of the value of all these gifts, but they aggregate an enormous amount. At the present time the Federal government is devoting more than ten millions annually to the work of the scientific departments of the government. At the very beginning of organized government in this commonwealth the question of education was one of the first with which the State concerned itself.

The principle of State aid to higher education, then recognized, has been since that time accepted by the general government and by every State government. In New England, Harvard and Yale and other foundations of higher learning are now dependent upon private endowments; yet almost every one of these has at one time or another received State aid. Harvard was in reality a State institution, having received from John Harvard only £800 and 320 books.

And while the more generous gifts to New England colleges have come from private sources, they have never hesitated, in time of emergency, to come before the representatives of the people and ask for assistance—these petitions have never been disregarded by the State.

The American republic may fairly claim to have adopted, and to have followed out Macaulay's motto: 'The first business of a State is the education of its citizens.' In no land and at no time has the State responded so quickly and so generously to the demand for higher education as in the United States of America, and during the last half-century.

If this aid had been rendered by an individual, if one could imagine the spirit of the whole people, both State and National, incarnated in a personal intelligence, which should take cognizance of the obligations of those whom the State had befriended, I can imagine that one of the most direct questions which such an intelligence would address to those who direct the education of the youth would be:

"I, representing the whole people, have given you freely of my national domain, the heritage of the whole people; I have founded and supported colleges and universities and technical institutions. What direct return has been made to me for this assistance, and have those who control the training of the youth kept in view their obligations to me and the dignity and the needs of my service?"

The question is a perfectly legitimate and a perfectly fair one. And while it is easy to answer it in generalities, it is not so easy to give a reply of that definite sort which shall lead somewhither. The subject is too large and has too many ramifications to be discussed in full on this occasion.

Perhaps the best I can do is to call attention to the importance of the inquiry itself, and to the obligation which exists for a definite and full, and most of all an honest answer. In addition, I shall endeavor to point out certain directions in which, to my thinking, the ends of government have been well served in our system of education, and certain others in which, it seems to me, we need improvement.

It may be stated as a general result that the State (using that term to characterize both the general government and the State governments), has been well served by the institutions of higher learning. It can be shown satisfactorily that in the main these institutions have not only served the general purpose of the diffusion of knowledge among men, that they have trained men in such a way as to make them more effective in the pursuit of their own fortunes, but also that they have given back to the State men well trained to serve it.

In a very real sense, education and science have been handmaidens of the State, for they have not only thrown their friendly light upon the problems of statecraft, but their children have been more numerous and more helpful in the service of the State than any other group of citizens. It may be said with perfect truthfulness that the higher institutions of learning have well earned from the State the assistance they have received.

Notwithstanding this general outcome, there are certain directions in which the State may reasonably demand additional results. It is to be remembered that the State represents, as does no other agency, the whole people, and in considering the obligations due the State, and the best method of discharging them, the institutions of learning are attempting to serve, in the most direct and, at the same time, in the broadest way, the whole body of citizens.

One thing which the government has a right to expect of those educated in the higher institutions of learning is a decent respect for the service of the State.

I am sure I express the sentiment of all men of serious purpose who have stood in executive places in Washington when I say that there is no greater source of discouragement to those who are honestly striving for good administration than the facility with which good and honest and intelligent men will ascribe the worst motives to those in government office.

Again and again a man of pure life and of high purpose, who has accepted a post under the government, discovers with infinite pain and surprise that the silliest charge against him is accepted, not only among the idle and the curious, but by those upon whose support he had most counted. This tendency is not peculiar to our time or to our nation. It is a part of 'that touch of nature which makes the whole world kin,' a kinship as universal as it is detestable.

One cannot think of the failure to discriminate between the dishonest few and the honest many, of the courage brought to failure by the wellnigh universal suspicion, of the unmerited pain, from Washington's day to this, inflicted by the careless judgment of men's motives, without recalling the words of Edmund Burke: "It is very rare, indeed, for men to be wrong in their feelings concerning public misconduct; as rare to be right in their speculation upon the cause of it. I have constantly observed that the generality of people are at least fifty years behind in their politics. There are very few men who are capable of comparing and digesting what passes before their eyes at different times and occasions so as to form the whole into a distinct system. But in books everything is settled for them without the exertion of any considerable diligence of sagacity. For which reason men are wise with but little reflection,

and good with little self-denial in the business of all times except their own."

Let me say that no man can be brought into contact with the actual machinery of our government, can mingle with the men who make our laws, who interpret them and who execute them, without gaining not only a wholesome respect for the service of the State, but also a reasonable hopefulness for the future of our institutions.

So far as my judgment goes, there are few conventions of men brought together for any purpose in which the average of intelligence and of honesty is higher than in the American Congress. It goes without saying that its members are influenced by personal considerations, by social ties, by all the things which move men—in other words, they are human—but it is a gathering of men who honestly desire to do the right thing.

It is the fashion to speak of the honesty and the intelligence of the good old days when the republic was young and when statesmen were pure, and to deprecate the decadence of the present day. Such talk is the purest nonsense. The general intelligence of the body of Congress is higher to-day then it ever was, and its conscience is quite as acute. Unfortunately, the work of quiet and serious men receives little attention from the public, although these men count enormously in the actual work of legislation.

In the executive branches of the government as well, one will find a quality of service to command respect. There are incompetents in greater numbers than one could wish, but the quality of men entering government service is improving steadily since the civil service law has made it possible for men of education and energy to find a career there. And, notwithstanding the half-hearted service of the few, it is true that the government receives quite as much of devotion and of unselfish service as one can find in the ranks of those engaged in private business.

The government of the United States is honestly conducted. Its condition furnishes to those who know it best the basis of a rational optimism as to the future of democratic institutions. In its service men of education should find, in increasing numbers, careers of the highest usefulness and of the highest dignity.

Another quality of the education given to the youth upon which the State has a right to insist is its catholicity. The State makes no distinctions in the matter of education. It aims to make its highest training accessible to the humblest as well as to the most aristocratic.

No system of education is a good one for a free State in which the students and graduates of its institutions of learning get out of touch with the great body of their fellow-citizens. Such a lack of contact between the men of education and those who lack education brings about a feeling of distrust as between men of two distinct classes. Under such circumstances the educated man is likely to lose the perspective concerning social facts and tendencies, and becomes suspicious and narrow; to feel that the country is fast going to the bad, and that the advice and the service of the educated man are not properly appreciated.

One of the practical results of this feeling has been that the college man has not always realized that he was to take his place side by side with the man who had no college education; that he must expect to begin where the uneducated man begins, and that his education was not a mark to distinguish him from other men, but a training which ought to enable him to do his part of the world's work better than the man who lacked this training, but that he was not one whit better, nor was he to receive the slightest consideration because of his better opportunity.

It is the protest againt this feeling of superiority, whether real or imagined, which is at the basis of most of the objections now offered to a college education as a preparation for the active work of life. The feeling is voiced in the following words from the late Collis P. Huntington. In a magazine article published just before his death, entitled 'Why Young Men should not go to College,' he says: "Somehow or other our schools which teach young people how to talk, do not teach them how to live. It seems to me, that slowly, but surely, there is growing up a stronger and stronger wall of caste, with good, honest labor on one side and frivolous gentility on the other."

In so far as this charge is true that a college training tends to make those who receive it a class apart, and prompts them to make extravagant demands, in just that proportion is it a fair criticism of our system of instruction. We have a right to expect that the college trained man, more than any other, shall be tolerant and patient. That he shall understand, as no one else can, that truth and honesty and virtue belong to no age and to no nation; that they are the property of no party, and no sect, and no class. And we have a right to expect that, realizing this, he shall have wholesome views regarding human nature. If the college atmosphere does not encourage all this, then the college atmosphere needs quickening.

In the great wave of enthusiasm for education which has been the remarkable social phenomenon of the last quarter-century's progress it was, perhaps, to have been anticipated that some mistakes of this kind would occur. When education—and a very narrow conception of that term—was proposed as a cure for all ills, it was natural that some should assume that the man who received a certain training should also receive, *ipso facto*, special consideration in the world.

How far this criticism has been justified in the past I do not feel able to say. I do believe, however, that the college spirit of to-day is wholesome and catholic; that the men in the higher institutions of learning are in closer touch with the great body of mankind than ever before, and that men who go through college and take their places in the world do so in accordance with the rules of common-sense.

But beyond all such questions, and including them all, is another in which the state is vitally interested, and this is the quality of citizenship which our system of education is adapted to produce. This I hesitate to approach, since to discuss it is to open the whole question as to what the object of education is and what subjects should be taught to accomplish that object.

It is the old question which has been discussed for 2,500 years, and never more vigorously than during the past decade. However we have improved the methods, we have certainly never been able to state the questions involved more clearly than the old Greeks. Listen to Aristotle; he writes:

"What, then, is education, and how are we to educate? As yet there is no agreement on these points. Men are not agreed as to what the young should learn, either with a view to perfect training or to the best life. It is not agreed whether education is to aim at the development of the intellect or of the moral character. Nor is it clear whether, in order to bring about these results, we are to train in what leads to virtue, in what is useful for ordinary life, or in abstract science."

Could any modern state more aptly or in fewer words than these, the questions which have formed the basis of discussion during the last quarter-century among those interested in education, with the marked difference that education for the development of character is less talked about.

Is education to have for its object the training of the intellect, or is it to aim at the development of character, or is it to undertake both objects? And if the character is to be developed, what are the formal means which are to be used in this development?

These questions have been asked anxiously since systems of education had their beginning. In our day they seem to have settled themselves, so far as the practical efforts of the universities and colleges are concerned, by a process of exclusion. It is tacitly assumed, at present, that education —like all other training—has for its end the acquisition of power. In order to acquire power quickly the whole effort in modern education is directed toward the training of the intellect.

There is no disputing the fact that the educated man has in the world a higher potential by reason of his education. Is it equally true that he has, on the average, a stronger and higher type of character? Is the college man broader in his sympathies, more tolerant, more courageous, more patriotic, more unselfish by reason of his life in the walls of a university or of a technical school? Are the men who come each year, in ever-increasing thousands, from the college doors, prepared to shoulder more than their proportionate share of the burdens of the State and of the country, or are they provided with a training which will enable them to more easily escape its obligations?

Let there be no misunderstanding in this matter. Whatever our system of education is doing or is leaving undone in the development of character among its students, the State is saying in terms which are becoming every day more emphatic, this:

However desirable it is to train the mind when it comes to the service of the State (if, indeed, the same is not true in all service), character is above intellect. It is vastly important to the State that her servants shall be quick, keen-witted, efficient, but it is absolutely necessary that they shall be honest, patriotic, unselfish; that they should have before them some conception of civic duty and proper ideals of civic virtue. Give me men, intellectual men, learned men, skilled men, if possible, but give me men.

It is the old story, this cry. It is the lesson which every age preaches anew to the age about to follow. Shall we ever learn it? Will it ever come to pass that in our system of education the development of character will go hand in hand with the development of the intellect; when to be an educated man will mean also to be a good man?

Probably no one looks upon Plato's Ideal Republic as the basis for any effort in practical politics, nevertheless it ought to be true that civic virtue should be a part of the life and of the environment of our seats of learning, and that men, along with the training of their minds, should grow into some sort of appreciation of their duties to the State, and come to know that courage and patriotism and devotion rank higher in this world's service than scholarly finish or brilliant intellectual power.

When we look back on our own history as a nation we can but realize that in the crises of our national life this truth has been forced home to us. In the darkest hours of the revolution it was the courage, the never-failing patience, the unselfish devotion, in a word, the civic virtue of George Washington which was the real power upon which the people leaned.

In the agony of our civil war, when the fate of the nation trembled in the balance, the character of Abraham Lincoln, his devotion, his hopefulness—above all, his knowledge of and his faith in the plain people—counted more than all else in the decision. Neither of these men was the product of

university training, nor did they grow up in an academic environment; but each had learned in a school where devotion to the State was the cardinal virtue. When next a great crisis comes, no doubt there will be a Washington or a Lincoln to meet it, but will he come from a university?

When Washington came toward the close of his life he thought deeply over the dangers of the new State and the necessity for the cultivation of a spirit of intelligent patriotism. As a best means for inculcating this spirit he conceived the idea of a great national university. One of the main objects of this university was to afford to the youth of the country the opportunity for 'acquiring knowledge in the principles of politics and good government.' The idea was a splendid one, and while the need for a national university no longer exists (unless, indeed, one is needed to teach the principles of good politics), Washington's idea that the university is a place which should train not only the intellect, but the character; that it is a place where the student should find an atmosphere adapted not only to the development of accurate thought, but also to a wise and tolerant spirit; that in the university he should gain not only intellectual strength, but also a just conception of the duty to the State, was a right view.

And until this is recognized; until we bring into our college life and into our college training such influences as will strengthen the character as well as the intellect; until the time shall come that the educated man shall by reason of his training be not only more able than his untrained neighbor, but also more patriotic, more courageous, better informed concerning the service of the State, and more ready to take up its service; until such a spirit is a part of our system of higher education, that system will not have served the ends which education should serve in a free State and for a free people.

And in this connection I cannot refrain from a reference to the aim of those who founded the Institute of Technology, and to the conception of duty which they have impressed upon the institution. The recognition of the value of exact science as a means for the training of mind came slowly. Even after it did come men were slow to recognize the value to the race of the results of science. The spiritual side of scientific research is a matter which even to this day men are slow to comprehend, notwithstanding the powerful effect which it has had during the last generation upon the thought and upon the conscience of the world.

"Newton was a great man," writes Coleridge, "but you must excuse me if I think it would take many Newtons to make one Milton."

Forty years ago there were few men in this republic who appreciated in any clear way the value of science in the training of men. To William B. Rogers, and to those who labored with him, belongs the credit of anticipating the value of this training and the demand for it.

But outside and beyond all these considerations of fitness and of practical results attained, they also impressed upon the institution certain principles which are dominant in its life to-day. One of these concerns itself with the very situation and environment of the institute.

The Institute of Technology has its roots in the same soil which supports the industrial life of the city and of the nation. Its contact with the practical side of life is immediate and real. It not only draws its strength thence, but expresses as only that can which has a real and vital connection, the aspiration of those who labor in science for the upbuilding and the improvement of civilization. The Institute of Technology not only aims to serve the people: it is itself of the people.

One of the lessons which the study of

exact science leaves with the student is the necessity not only for exact work, but for a high ideal. Science is satisfied with nothing short of perfection, and this principle when it pervades a body of men comes to govern and control the spirit in which their work is done. No better heritage can be left to any institution than that which has been faithfully handed down to you, namely, in education it is not sufficient to be merely accurate, but it is necessary to hold fast to the highest ideal.

Once this idea gains control of a student life, that student will undertake faithfully and courageously whatsoever duties lie before him, whether they concern his professional life, his social life or his country's service.

Let me add, in conclusion, a word of personal greeting, speaking as one may when he addresses those who have come together, drawn by a common interest.

In the name of the corporation, and of the faculty, and of the students of the Institute of Technology, I thank those who represent here other institutions for your presence on this occasion. Your coming is not only a source of pleasure, but of encouragement to us, and helps to emphasize that spirit of common interest and of common helpfulness which ought ever to mark the relation of those who have to do with education. The Institute of Technology extends to you, and through you to the institutions which you represent, the assurance of its cordial good feeling.

Two of those who sit upon this platform the President of Lehigh University and the President of Harvard came from the faculty of the institute. This fact gives to your presence here an additional element of interest, and we extend to you a special greeting.

To Lehigh University in the sturdy work which she has done and is doing, for the courage with which she has not hesitated to face difficulties, we extend our warm congratulations.

To our near neighbor, the oldest and largest of American universities, we offer most hearty greeting. We rejoice in the greatness and in the strength of Harvard University, and take courage in the thought that we join hands with her to-day—as an elder sister—in a work not only for this city and for this commonwealth, but for humanity.

Gentlemen of the Corporation: In accepting the responsibility which you have this day formally invited me to share with you, I do so hopefully and with full confidence in you, in this community, and in the future. There is no greater work committed to men's hands than that to which we are called.

As I think of those who have preceded me in this place, when I call to mind their splendid services to the institute, to the commonwealth and to the country, I accept this work with a feeling of great humility, but with the earnest hope that through our common effort the institution may grow not only in strength, but in usefulness; not only in facilities for work, but in the better understanding of what work means, and that it may ever seek to lead in all that concerns the rational and helpful teaching of applied science.

Gentlemen of the Instructing Staff: For the cordial welcome to your number I am most grateful. I come to you with no new message and as the herald of no new gospel. The same spirit of work and of devotion which has been the glory of your body in the past must be our source of strength for the future.

In all that leads to the uplifting of technical education in the development and extension of the work of the institution, in the suggestion of new means by which it can minister more directly to the work of education upon the one side, and to the

promotion of scientific research upon the other, I ask your hearty cooperation and assistance. An institution, like an individual, must grow in its experience, in its appreciation of truth, in comprehension of the meaning of art and of science and of life, if it is to minister to a growing civilization. The inspiration which shall stand back of this growth must rest, in large measure, upon your zeal and your effort.

Alumni of the Institute: To each of you has been mailed an invitation to this gathering. These missives have gone to every country and to every climate. Some are at this moment being borne on the backs of men or in snow-sledges to the interior of Alaska, to be read months hence amid the winter snows. Some will be read in the tropics, under the glare of a summer sun.

Your alma mater would gladly have welcomed each one of you this day to her fireside, though the fare be frugal and the feast modest. Since this cannot be, let her invitation carry at least this suggestion: How farsoever from her halls your path may lead, it can never take you beyond the circle of her affection.

The institute is proud of the men it has sent forth, and she counts upon their loyalty and their devotion. She invites your counsel, your suggestion, your friendly criticism, your help. And while she listens with willing ear to every voice which rings true, she asks you to remember that no greeting so thrills her as that which comes up from one of her own children who is doing a man's work in the world.

Students of the Institute: In a more real sense than any other body you are the Institute of Technology. As such I salute you to-day, and assure you not only of my earnest wish for your advancement and your success, but also of my wish for your friendship and for your help. I prefer to think of such an institution as that in which we work together, not as an empire governed by the few, but as a republic in which faculty and students alike are charged with the government of the whole body.

I congratulate you on taking up the study of engineering, using that term in the broadest sense. There was never a more opportune time to enter such work, nor was there ever a period in the history of our country when the trained engineer had open before him so attractive a field.

This is the day of the trained man, and to him the responsibilities and the rewards will go. To the American engineer a whole series of new problems of the highest interest have in recent years been presented. Railways are to be built, canals are to be cut, a whole empire of desert land is to blossom under his hand. The Pacific Ocean and the countries which border upon it are to be the theater of an enormous development.

Cables will be laid, cities will be developed, the tropics will be subdued. In all this development the engineer, the trained engineer, is to play a rôle that he has never yet played since civilization began. The next quarter-century is to belong preeminently to him, and in all these world problems and world enterprises you are to share.

May I hope that in your preparation you may bear in mind as your ideal of an engineer, not only one who works in steel and brick and timber, but one who by the quality of his manliness works also in the hearts of men; one who is great enough to appreciate his duty to his profession, but, likewise, and in a larger and deeper sense, his duty to a common country and to a common civilization. H. S. Pritchett.

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*ENGINEERING EDUCATION IN THE UNITED STATES AT THE END OF THE CENTURY.**

There is no reason apart from custom why any special significance should be at-

* Address of the President of the Society for the Promotion of Engineering Education.

tached to the arbitrary measure of time that we call a century. The main course of history is not much affected by the arbitrary transition from one century to another. But custom has established the turn of the century as an appropriate time to record the past and forecast the future. Since to this Society is entrusted more than to any other agency the future of engineering education in this country, and since we as a nation have risen out of the Monroe doctrine and our isolation, and have taken our first steps to become one of the number of great powers that assume to direct the course of civilization and decide the destiny of the rest of the world, and since this nation largely through the work of the engineer is making rapid progress toward the commercial conquest of the world—the present seems an auspicious occasion on which to study briefly the progress of engineering education.

The century just closing has witnessed a marvelous development in all matters relating to education. Probably the most remarkable feature of the educational history of the century is the extension of the opportunities of an education to the common people as a right. To-day there is nothing in this country so free as education, and the United States is far in the lead of foreign countries in school attendance, about one-fourth of the school population of the world being Americans.

At the beginning of the century there were thirty colleges in the United States with about 3,000 students, while to-day there are 472 collegiate institutions with 155,000 students. But the mere increase in numbers is not the most significant feature. The colleges then were of a lower grade than most academies to-day. This is the explanation of the frequent mention in the biographies of men of that time that they graduated at the age of 15 or younger. The remarkable improvements in the methods of instruction have been both a cause and an effect of the popularization of education.

Another important element in the development of education in America has been the munificent contributions of individuals and of governments to the cause of education. The movement in this direction, during the closing years of the century, has been at a rapidly accelerated rate, and is therefore an element of great promise for the future.

Technical education, the application of the sciences to the needs of man, is a growth entirely of this century. Apparently the first technical school in the world was the École Polytechnique in France, established in 1794 to train men for the artillery and engineering corps of the army. The U. S. Military Academy was founded in 1802, and for more than thirty years thereafter was the only organized agency for engineering education in America. For three-quarters of a century a surprising proportion of the graduates of this institution practiced engineering in civil life, not because the education there given was what would now be called engineering instruction, but because it was the best preparation for engineering practice that could then be obtained. Apparently this fact has been overlooked alike by friendly and unfriendly critics of this noted institution. In 1825 at Troy, N. Y., was organized the first institution in the world for giving instruction in engineering not military. Apparently at the time of the founding of this institution the term civil engineering had not been coined, the word engineering being synonomous with military engineering.

For thirty years after the establishment of the engineering school at Troy, *i. e.*, from 1825 to the close of the civil war, only four engineering schools were founded, of which only two were really entitled to the name engineering. During this time the engi-

neering schools gave but little technical instruction; most of the so-called engineering part of the course consisted of mathematics and elementary science.

In 1862 Congress passed an act giving to the several states public lands for the benefit of 'instruction in the arts and sciences relating to agriculture and the mechanical arts.' Shortly after the close of the civil war many of our engineering schools were organized under this act. Never was there a movement more timely or more successful than this, since it has resulted in the establishment of sixty-four technical colleges—at least one in each state and territory. Fifty of them give instruction in one or more branches of engineering.

The number of institutions at present giving instruction in engineering is shown in Table I. The institutions are classified

TABLE I.

Number of Institutions giving Instruction in Different Branches of Engineering in 1898–99.

Institutions.		Number Offering Courses in						
Grade.	No.	C. E.	M. E.	E. E.	Min. E.	Arch.	Nav. A.	E.
Class A	30	27	21	21	5	8	2	2
Class B	27	24	17	14	10	6		
Class C	20	12	12	7	5	1		
Class D	9	1	9	5				
Class E	3	3	2	2	1			
Total	89	67	61	49	21	15	2	2

with reference to their requirements for admission according to the scheme presented by the Committee on Entrance Requirements—see the annual report of the Society for 1896, pages 103–4. The report of the Committee includes 110 institutions, but the writer concludes from a careful study of their catalogues that at least twelve of these have no engineering course. The writer has received no report from seven of the United States institutions listed by the Committee, nor from the two Canadian engineering schools.

Table II. shows the number of students in the several branches of engineering for the year 1898–99; and Table III. the number of graduates for the year 1899. These data were collected from the institutions for this purpose. A few schools were not heard from, but in each case they were small ones having few, if any, engineering students, which fact probably accounts, in some cases at least, for their failure to report. Therefore, Tables II. and III. may be considered as representing the total number of

TABLE II.

Number of Students in Different Branches of Engineering in 1898–99.

Institutions.	Number Offering Courses in							
	C. E.	M. E.	E. E.	Min. E.	Arch.	Nav. A.	S. E.	Total.
Class A	1359	1579	1405	245	366	54	19	5027
Class B	794	435	510	313	20			2072
Class C	463	919	299	298	3			1902
Class D	10	337	156					503
Class E	41	23	27	4				95
Total	2667	3293	2397	860	389	54	19	9679

engineering students and graduates for the year 1898–99. During the decade 1889–99 the number of students increased from 3,043 to 9,659, or 317 per cent.; and the graduates increased from 483 to 1,413, or 242 per cent. However, in this connection averages are misleading, since the rate of growth for the different courses vary greatly. For

TABLE III.

Number of Engineering Graduates in 1899.

Institutions.	Number of Graduates in							
	C. E.	M. E.	E. E.	Min. E.	Arch.	Nav. A.	S. E.	Total.
Class A	210	299	252	43	54	9	1	868
Class B	143	52	77	14	2			288
Class C	56	89	27	21				193
Class D	5	37	11					53
Class E	5	3	3					11
Total	419	480	370	78	56	9	1	1413

example, from 1889 to 1899 the increase of civil engineering graduates was 56 per cent., and of mechanical 117 per cent.; while the entire growth in electrical engineering is practically a matter of the past decade.

Table IV. presents some interesting statistics as to engineering education in comparison with the so-called three learned professions—theology, medicine and law. The data for the first three columns of need of these data was not foreseen when those in the preceding tables were asked for. Farther, the value of a year of high-school study varies greatly even within the limits of a single State, which adds materially to the difficulty of making a correct general statement as to the conditions for admission.

There are several matters in these tables that invite discussion. For example: 1.

TABLE IV.

PROFESSIONAL EDUCATION IN THE UNITED STATES. DATA FOR 1898–99.

Item.	Theology.	Law.	Medicine.*	Engineering.
Number of Schools,	165	86	156	89
Growth since 1878,	32%	144%	82%	21%
Number of Instructors,	1070	970	6416	
Number of Students,	8099	11833	26088	9659
Growth since 1878,	87%	294	142%	516%
Number of Graduates,	1193	3110	5725	1413
Requirements for Admission,				
College Degree,	43%	2.3% Require College work.	0.7%	1.1%
Completion of Junior Year,	2			
Completion of Freshman Year,	11			
4-yr. High School Course,		3.5%	8%	4.1
3-yr. " " "	11	14	2	24
2-yr. " " "	4	13	3	51
1-yr. " " "	1	9	62	17
Common " "	11	30	19	
None or Indefinite,	17	28	1	4
Total Reported,	100%	100%	100%	100%
Length of Course,				
4-yr. Course,	24%		91%	98%
3-yr. Course,	70	51%	6	1
Less than 3-yr.,	4	43	3	1
Total Reported,	98%	94%	100%	100%
Average Length of Yearly Session,	8 mo.	7¼ mo.	7 mo.	8.7 mo.

Table IV. were compiled from Bulletins 7, 8 and 9—'Professional Education in the United States'—published by the University of the State of New York.

The data in Table IV. concerning the length of high school course required for admission to engineering schools must be regarded as only roughly approximate. It is difficult for one not acquainted with all the facts to determine from the catalogue just what the requirements are; and the

* Does not include Dentistry, Pharmacy and Veterinary.

Why do so few institutions offer instruction in architecture?—see Table I. Why so few students in architecture?—see Table II. 2. The significance of the fact that more than half of the engineering students are receiving their education in Class A institutions, *i. e.*, those having the highest requirements for admission—see Table II. 3. Are the number of graduates more or less than required to fill the ranks of the profession? 4. Is the number of engineering graduates greater or less, in proportion to the demands of the profession, than law and med-

icine? 5. Do the data in Table IV. justify the usual classification of schools of law and medicine as post-graduate and engineering as under-graduate? In this connection the fact must not be overlooked that some of the students in law and medicine have more or less college training before entering upon their professional course, and the same is true in engineering but to a much less extent. Time forbids a consideration of these questions here.

But statistics can not represent the most important developments in engineering education in the last third of the closing century. Immense strides have been taken in both the methods and the scope of instruction. At the close of the civil war there were nominally only six institutions giving any grade of instruction in engineering; and for ten or fifteen years thereafter, the engineering instruction offered by the best institutions is hardly deserving the name in comparison with that offered by many institutions at the present time. During this period some of the engineering instruction was practical and not scientific, and some was scientific and not practical; but none of it consisted of the principles of scientific engineering, nor of the relations of the sciences to engineering problems. Text-books were few and poor. The equipment of the schools was inadequate. Then the student went to college to learn details of practice and to fill his note-book with formulas; he was reluctant to give his best efforts to the acquisition of fundamental principles and to the development of the ability to see straight and to reason correctly. Happily now all that is changed, and the schools of America are now offering unexcelled facilities for the acquisition of the fundamentals of an engineering education, and the students are laboring heroically to ground themselves in the principles of scientific engineering.

Twenty-five years ago practitioners had doubt as to the value of a technical training for young engineers, and distrusted the engineering graduate; but now general managers and chief engineers prefer technical graduates, since they have been trained in scientific methods of working, and have a knowledge of the fundamental principles underlying all engineering practice, and look out upon the world of truth from the view-point of a man of science. The national engineering societies now give credit for training in the engineering school toward the requirements for admission to membership. The most cordial relations now exist between practitioners and the schools of engineering. Within recent years, largely if not mainly through the influence of the technical schools, engineering has ceased to be traditional and has become scientific.

The technical school met with no welcome from the older colleges and universities. In the beginning the devotee of the non-technical subjects was not willing to admit the study of engineering as being upon the same high plane as that of literature, history and philosophy. Now all who know the facts are ready to admit that the engineering student secures greater advancement during his college career than any other undergraduate. This result is due to the definiteness of the aim of the engineering student, to the stimulus of professional preparation and to the nature of the study.

One of the most important advances in engineering education has been the introduction of the laboratory method of instruction. Now all the better institutions have extensive and well-equipped laboratories fitted up especially for experimental work, in which the student receives instruction of the very highest value. In this respect our American schools are unrivaled in the world. In Europe, particularly in Germany, are some notable

and well-equipped engineering laboratories which have done much to advance engineering science, but which are used by experts in research and commercial work and not for purposes of instruction. Although our engineering laboratories are maintained primarily for purposes of instruction, a considerable amount of research work is performed in them.

The curriculum of the engineering college at present consists of about 10 per cent. of English or modern foreign language, usually the latter; 30 to 40 per cent. of indirect technical studies, as mathematics, physics and drawing; and 50 to 60 per cent. of technical work. The tendency is to make the engineering courses as completely professional as are courses in law and medicine. Experience has shown that it is impracticable to teach culture subjects in a course with strongly marked technical tendencies, since the student devotes all his time to the latter and neglects the former. Very recently there has been a tendency to force some of the indirect technical subjects, as advanced algebra and trigonometry, into the preparatory school to get more time in the engineering college for directly technical subjects. The effect of this is still further to curtail the culture studies of the engineering students by eliminating these subjects from the preparatory course.

A number of institutions offer post-graduate instruction in engineering; but the number doing post-graduate work in engineering is less than that in science or literature. In 1898–99 at twenty-three leading institutions the average per cent. of graduate to undergraduate students in non-engineering departments was 9.94; in the engineering departments, 2.3; or, in other words, the per cent. doing graduate work in non-engineering courses is more than four times greater than in engineering courses. In the above computations graduates doing undergraduate work are considered as undergraduate students But few, if any, Americans now attend European engineering schools, for it is generally conceded that the American schools, in equipment, methods and scope of instruction, are superior to any European schools, at least for American engineers. There are at least three reasons for the relatively small number doing graduate work in engineering:

a. In many cases, if not in a majority, the chief object of post-graduate study is to secure the preparation necessary for teaching the subject. In many branches the whole range of study, both undergraduate and post-graduate, is purely academic and can be obtained in college environments better than anywhere else. But in engineering the prospective teacher must secure a personal acquaintance with the conditions of practice, which can be obtained only by engaging in actual engineering work. In short, the future teacher of engineering prefers to engage in practice after graduation rather than to return to college halls for further study.

b. Probably many students pursue an engineering course chiefly because it promises an early means of securing a livelihood, and not unnaturally feel that they can ill afford the means required for post-graduate study. Others who are financially able to continue collegiate work beyond graduation are more anxious to have a part in the activities of the outside world than to pursue post-graduate study. At present the demand for engineering graduates is such that in both of these classes, at least those that are really deserving, find little or no difficulty in obtaining remunerative positions in practical engineering work. The engineering college is attempting to give a professional training to its graduates, and it is not surprising that they are anxious to apply in practice that which they have been studying in college. A few years ago many

engineering students were unable to resist the seductive offers of positions in actual practice, and left college before graduation. Recently the demand has been almost exclusively for graduates, and now a much larger proportion than formerly stay to graduate. When the competition of young engineers for positions becomes greater, as it doubtless will, probably a greater proportion will be willing to engage in post-graduate study. But this element may not become very effective in increasing the number of engineering students seeking advanced collegiate work, for some of them may prefer to serve for a time after graduation as apprentices at comparatively low salaries. Already there are evidences of a considerable tendency in this direction.

c. The third reason for the less number of post-graduate engineering students is by far the most important. Ordinarily post-graduate study is primarily intended for independent research work; and this is properly so, for after a young person has been under the direction of tutors for fifteen or twenty years, it is time that he should attempt to blaze a road for himself. If this research work is really original, it will inspire the highest ambition of the student, and will secure his utmost efforts. This class of work will always attract. But departments of study differ greatly in the opportunities for original research. The less fully developed branches of study doubtless have many unsolved problems waiting for investigation, and some of these are such that a recent graduate may reasonably be expected to solve them, or at least to collect part of the data required for a subsequent solution. Engineering post-graduate study offers fewer opportunities for this class of work than many other departments of collegiate work, because of the more fully developed state of most branches of engineering knowledge. Again, the nature of the investigations in many departments is such that they thrive better in a college atmosphere than anywhere else. This is not true, in general, of engineering investigations. Finally, and most important of all, original research in most departments of study is carried on only because of the enthusiasm of the investigator or by public or private benevolence; while in engineering most of the research work is done in connection with practical work at the expense of individuals or corporations or municipalities having a direct financial interest in the result. Many engineers devote a large part of their time to original research work, and nearly all practicing engineers have more or less of such work. The life of an engineering student before and after graduation is much more nearly continuous than that of a student in most other departments. The ambitious engineering student knows that, shortly, if not immediately, after graduation, he can secure actual engineering practice of high educational value, and many choose positions chiefly with reference to the value of the experience to be obtained. The salary, the educational value of practical experience, the possibility of promotion—all draw the engineering student away from post-graduate study. In other words, the study of engineering is essentially graduate work, and there will probably never be any considerable number who will pursue engineering studies beyond the present four-year course. But there are sufficient reasons why adequate provisions should be made for the competent and ambitious few who seek truly graduate instruction in engineering.

All the preceding is intended to show in rough outline the present state of engineering education, and particularly the rapid growth. The present phenomenal rate of progress promises still larger things for the future, and lays upon this Society important responsibilities in directing the

future development of engineering education in America. In this connection there are several matters which invite the careful attention of individual members of this Society, and possibly are worthy of official action by the Society itself.

1. Is any general movement for increasing the requirements for admission desirable? The standard has been rising quite rapidly within the past five years, particularly in mathematics, English and foreign languages; but even now comparatively few of the engineering departments of the universities have as high requirements for admission as the literary departments. Is this justifiable?

2. Is it wise to require advanced algebra and trigonometry for admission to the engineering courses? Is it wise to require prospective students to take these subjects in secondary schools to the exclusion of subjects in science, literature or history? Will the forcing of these subjects into the curricula of the secondary schools handicap them in discharging their just obligations toward students who are not seeking an engineering education? Which subject can the preparatory school teach the better? Which school will teach the mathematics the better?

3. At some institutions a considerable number of engineering students have had previous collegiate training. Can anything be done to increase their number?

4. Engineering courses have become so highly specialized that frequently students of one course receive no instruction in the fundamental technical subjects of a closely allied branch of engineering. This practice is burdensome upon the school and is probably not of the highest advantage to the student. But the colleges are not likely to retrace their steps, and therefore the highly specialized course is a condition to be reckoned with. Should anything be done to prevent further specialization? Some students correct the defects due to high specialization by remaining a fifth year and pursuing the allied course. Can anything be done to increase the number who do this?

5. The engineering course of to-day is so loaded with required technical and scientific work that the student has little or no time to cultivate those subjects, indefinitely, but not inappropriately, called the humanities. Engineering students, more perhaps than any others, need training in such subjects. Those who follow the other learned professions deal constantly in their technical work with the relationships of their fellow men, while the engineer in his professional work deals mainly with the inanimate world. The engineer has little opportunity to come into intimate relations with men either through the study of history, economics and sociology, or through personal contact. The engineer usually possesses strong character, sound judgment, thorough knowledge of his business; but frequently because of a lack of that knowledge which other men consider essential in a liberal education, he is ranked as a relatively uncultivated man, and therefore is unable to exercise the influence his training justifies, and fails to secure the reward his abilities merit. Can the instructors in engineering create in the mind of the engineering student such a hungering for a knowledge of the humanities that he will secure it after graduation by private study and personal intercourse?

Such, then, are the conditions and the problems of engineering education as we step into the twentieth century. The present conditions have been determined largely by the engineering colleges themselves in advance of the demands of the engineering profession and of the general public, and often in opposition to such demands. Chiefly through the influence of the engineering college the engineering profession

has developed during the past third of a century into a truly learned profession. There was never a time in the history of the world when the questions of general education were more carefully considered than at the present; and there was never a time when this country was more concerned with the work of the engineer than now. The nation, just awakening to a consciousness of its power and responsibility, is taking its place among the nations of the earth, and is seeking to decide the destiny of the peoples of the earth. We are now sending our manufactured products to all parts of the world, and if we are to have part in the commercial conquest of the earth, it will be because of the ability, the foresight, the wisdom of our own engineers. The only agency seeking to prepare engineers for their work is the engineering college. Their work in molding and directing the engineering education of the future will be no less important than in the past. They enjoy the respect and confidence of the public, and a still wider field of influence and responsibility lies open before them. May the deliberations of this Society continue to be a source of strength and inspiration to the engineering colleges. May the engineer of the twentieth century have better technical training, broader culture and nobler aspirations. May the profession of engineering come to occupy a still higher position in the esteem and respect of the public.

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PROGRESS IN IRRIGATION INVESTIGATIONS.

The organization and objects of the irrigation inquiries of the U. S. Department of Agriculture have been partly explained in an earlier number of this Journal.* Congress at its last session increased the appropriation for this work from $35,000 to $50,000.

It was realized at the outset of these investigations that a basis of settlement of the controversies over rights to water for irrigation purposes, which are very frequent and acute in the arid region, where the supply of water is limited, must be reached before it would be wise to attempt to greatly increase the use of water for irrigation. The uncertainty of water rights and ignorance as to the amounts actually needed for successful agriculture led irrigators to claim more water than they could possibly use, frequently more than the natural supply yielded, and encouraged extravagant rather than economical use of water. It was for this reason that the Department directed attention first to the collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and a number of bulletins dealing with this phase of the subject, as well as with general irrigation practice, have been published. At the same time it was realized that an exact knowledge of the water requirements of cultivated plants at different stages of growth and under varying conditions of soil, climate, etc., is fundamental to an economical, rational practice of irrigation. It was therefore determined that one of the two main lines of work undertaken should be the collation and publication of information regarding the use of irrigation waters in agriculture as shown by actual experience of farmers and by experimental investigations. It was decided, however, that the strictly scientific studies provided for in this plan could be more intelligently pursued after the actual practice as regards irrigation in the various localities where it is already engaged in had been ascertained. Inquiries having the latter object in view were planned and put into operation on a comprehensive scale. The results of the

* Science, 11 (1899), p. 798.

first year's work along this line are given in a bulletin * on 'The Use of Water in Irrigation,' which is now in press. This bulletin deals with the methods in use in the arid States in the distribution and use of water in irrigation, and gives a large number of measurements made to determine the 'duty of water' and the losses from seepage and evaporation in canals; and discusses the methods by which the water supply may be more effectively and economically applied to crops. It contains papers discussing the results of the year's investigation by Elwood Mead, expert in charge; tables for use in measuring water and diagrams showing use, by Clarence T. Johnston, assistant; and reports and discussions of irrigation investigations in different localities by special agents Thomas Berry, Colorado; W. M. Reed, New Mexico; W. H. Code, Arizona; W. Irving, California; R. C. Gemmell and George L. Swendsen, Utah; D. W. Ross, Idaho; Samuel Fortier, Montana; and O. V. P. Stout, Nebraska. The bulletin is illustrated by numerous plates, diagrams, and maps showing the location and character of the investigations made. It is probably the most complete collection of data on the 'duty of water' in irrigation which has ever been published, and is especially valuable because it is based on measurements, systematically planned and synchronously made, of the amount of water actually used on a large number of farms in widely separated portions of the arid region.

Among the important facts brought out in the report is the enormous loss of water from canals and reservoirs by seepage and evaporation. From actual measurements made it is estimated that in some cases at least the loss from these causes might be so far reduced by better methods of construction and management as to double the area at present irrigated by the canals. Attention is also called to the large losses occurring when water under small head is spread in a thin layer over soils heated to the high temperatures common in some parts of the arid region, and to the great advantages of rotation in the use of water as contrasted with the wasteful methods encouraged by the common system of contracts which gives to the irrigator the right to a uniform and constant flow of water. The results, therefore, not only furnish the basis for improving methods of irrigation already in use and for framing more equitable laws, but it is believed that they indicate more clearly the lines along which strictly scientific inquiries may be most successfully directed.

Owing to the absolute dependence of agriculture upon irrigation in the arid region, attention was first directed to the irrigation problems of that region, but the work is being extended to the eastern or so-called 'humid' portion of the United States, for the necessity for irrigation is by no means confined to the region west of the hundredth meridian. The aggregate loss from total or partial crop failure as a consequence of periods of drought in the region where the rainfall is usually considered sufficient for the needs of agriculture is far greater than is generally realized. This fact is clearly brought out in a report by E. B. Voorhees on 'Irrigation in New Jersey.'* This bulletin discusses the need of irrigation in New Jersey, reports the results of experiments at the experiment station at New Brunswick and elsewhere in New Jersey during 1899 to determine whether irrigation during periods of drought is a profitable undertaking, and gives descriptions and statements of cost of a number of small irrigation plants in New Jersey.

The rainfall records of Philadelphia for 70 years are cited to show the frequency of injurious droughts:

* U. S. Dept. Agr., Office of Experiment Stations, Bul. 86, pp. 248.

* U. S. Dept. Agr., Office of Experiment Stations, Bul. 87, pp. 40.

"In 62 years out of 70 there was one month in the growing season from April to August in which such a marked deficiency occurred as to cause a serious shortage of crop, and for the same period there were 39 years in which the deficiency extended throughout two months, while in 21 years it extended throughout three months, or in 30 per cent. of the years included in this record there were three months during the growing period in which the average rainfall was deficient one inch or more. It is thus observed that a wide series of crops would be likely to suffer in more than one-half of the years for which the record is available, while a still larger number would suffer in nearly one-third of the years, for it must be remembered that even a slight deficiency in one month may result in a serious reduction in yield and consequent loss, if it occurs at a time when the crop is making its largest development."

Some idea of the extent of the losses occasioned by such periods of drought may be gained from Professor Voorhees' estimate that the loss to the hay crop of New Jersey alone from the drought in May and early June, 1899, was $1,500,000, while small fruits, vegetables, and other crops were also seriously affected.

"In 1897 and 1898, years of abundant rainfall in April and May, the yield of hay [at the Station] averaged 2.65 tons per acre. In 1899 it was a fraction over one ton, owing to the deficiency of rainfall in April and May—at the low price of $10 per ton, a loss for the 25 acres of over $400. The yield of crimson clover forage for 1897 and 1898 was 8.5 tons per acre; in 1899 the yield was but five tons, or in a good year the yield was 70 per cent. greater. The deficiency in the rainfall at the critical period was alone responsible for this difference in yield. . . . Oat and pea forage in 1897 and the early seeding of 1898 averaged six tons per acre; in 1899 the yield was but 3.3 tons."

In experiments at the Station with small fruits the increase in yield due to irrigation was as follows: Blackberries, 1,038 quarts per acre, worth $93.42; raspberries, 329 quarts per acre, worth $32.90; currants, 311 quarts per acre, worth $31.10. The results of similar experiments in other parts of the State with a variety of crops confirmed those obtained at the Station. These results show beyond question that supplemental irrigation under such rainfall conditions as those noted above is a profitable undertaking, especially on fruits and garden crops. Since the rainfall conditions described may be considered typical of the whole eastern half of the United States, the conclusions reached regarding the profitableness of irrigation are believed to be generally applicable to the agriculture of that region.

W. H. Beal.

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*REMEASUREMENT OF THE PERUVIAN ARC.**

In 1889 the question of the remeasurement of the Peruvian Arc was brought before the International Geodetic Association by the Delegate of the United States (Professor George Davidson, Assistant Coast and Geodetic Survey) who suggested that France should have a prior right to execute this work in consequence of the first measure having been made by her savants, members of the French Academy in 1736–43. Circumstances prevented any active work until 1898, when the discussion of the subject was renewed in the same Association as the result of a motion offered by the Delegate of the United States (Mr. E. D. Preston, Assistant Coast and Geodetic Survey).

The Association voted in favor of the proposition to remeasure the Arc and the French Delegates undertook to bring the matter to the attention of their government and to have an examination made, so that they could report to the next meeting of the Association at Paris during the present year.

Captains Maurain and Lacombe of the Geographic Service of the French Army left Paris in May, 1899, and remained in

* The information is derived from the *Comptes Rendus, hebdomadaires des Seances de l'Académie des Science*, No. 26, June 25, 1900 (page 1740), and the *Bulletin de la Societé de Géographie*, No. 7, July 15, 1900 (page 1).

Ecuador from July to November of the same year, successfully accomplishing in this time the reconnoissance for the new work.

Unfortunately all the marks left in the old work have been destroyed, even the base monuments having been demolished. According to the plan proposed the Arc of Quito which will replace the Arc of Peru covers 6° of latitude nearly double the length of the old Arc.

Fifty-two triangulation stations will be occupied. Three fundamental astronomical stations have been selected, one near Quito and one at each extremity of the Arc, where latitude and longitude will be determined. Other determinations of latitude will be made at intermediate stations to permit a study of the deviation of the vertical. Three base lines from eight to nine kilometers in length will be measured.

One is situated near Riobamba about the middle of arc and is to be connected with sea level by levels of precision which are expected to determine its elevation with an error not exceeding a few centimeters. Two verification base lines will be measured, one near each end of the Arc. Observation of gravity and magnetism will be made, and studies of topography, geology and other subjects of natural science undertaken. Quito possesses an observatory with modern instruments, in charge of a French astronomer, situated only fourteen minutes of latitude south of the equator, at an elevation of 3,000 meters above sea level.

To execute the measure of the new equatorial arc and complete the complementary studies that should be made in connection with it, it is estimated that five geodesists should devote four years of uninterrupted labor to this work. The difficulties to be overcome will tax the courage and scientific devotion of those upon whom the honor of its execution may be bestowed.

I. W.

SIXTH ANNUAL MEETING OF THE BOTANICAL SOCIETY OF AMERICA.

THE sixth annual meeting of the Botanical Society of America was held in New York City, June 26 to 28, 1900. For the reading of papers the Society met in joint session with Section G of the American Association for the Advancement of Science, June 28th, in Room 502, Schermerhorn Hall, Columbia University. The meeting of Section G was called to order by the Vice-President, Wm. Trelease, who announced the arrangements for the joint session and called B. L. Robinson, president of the Society, to the chair. The retiring president, L. M. Underwood, then read his address—'The Last Quarter: A Reminiscence, and an Outlook.' The full text of the address has already been printed in SCIENCE.

Following is the program of papers presented:

'The Significance of Transpiration': C. R. BARNES.

'Relationship and Variability of the Adirondack Spruce': CHAS. PECK.

'Nuclear Studies on Pellia': B. M. DAVIS.

'On the Structure of the Stem of *Polytrichadelphus dendroides*': MRS. E. G. BRINTON.

'Observations on the group Yuccæ': WM. TRELEASE.

'Spermatogenesis in the Gymnosperms': J. M. COULTER.

'The Pollen Tube, and Division of the Generative Cell, in Pines,' by invitation of the Council: MISS M. C. FERGUSON.

'On the Homologies and Probable Origin of the Embryo-Sac': GEO. F. ATKINSON.

'Observations on Leisonia': CONWAY MACMILLAN.

'Thigmotropism of Roots': F. C. NEWCOMBE.

'Starch in Guard Cells': B. D. HALSTED.

'Coenogametes': B. M. DAVIS.

'The Development of the Archegonium, and Fertilization in the Hemlock Spruce,' by invitation of the Council: W. A. MURRILL.

'The Causes Operative in the Formation of Silage,' by invitation of the Council: H. L. RUSSELL and S. M. BABCOCK.

'A Closed Circuit Respiration Apparatus,' by invitation of the Council: H. L. RUSSELL and S. M. BABCOCK.

The officers for the ensuing year are: *President*, B. D. Halsted; *Vice-President*, R. A. Harper; *Treasurer*, C. A. Hollick; *Secretary*, G. F. Atkinson. *Members of the Council*; B. D. Halsted, B. L. Robinson, R. A. Harper, C. A. Hollick, G. F. Atkinson, C. E. Bessey, F. V. Coville.

An important step was taken by the Society in appointing a committee to consider the best means of realizing the purposes of the Society, 'in the advancement of botanical knowledge,' as defined in the constitution. Among other things this committee will consider the uses to which the accumulating funds of the Society may be put. The committee will report at the next annual meeting of the Society.

Geo. F. Atkinson,
Secretary.

SCIENTIFIC BOOKS.

PUBLICATIONS OF THE EARTHQUAKE INVESTIGATION COMMITTEE—IN FOREIGN LANGUAGES, NUMBERS 3 AND 4 TOKYO—1900.

There is one science which the Japanese have practically made their own. Blessed or cursed (according to how you look at it), by the frequent occurrence of earthquakes, and blessed (certainly) by the presence of a large number of able and enthusiastic students of physical science, Japan has become within twenty years a vast seismological laboratory in which seismic phenomena are being studied as they never were before. Indeed, modern seismology had its birth there, and there it has been and is being most carefully nurtured. About twenty years ago there were in Japan a considerable number of foreigners employed as professors of engineering, geology, physics, etc., and of necessity they became interested in the one characteristic natural phenomenon, the unpleasantly frequent manifestations of which none of them will ever forget.

In the observational study of earthquakes one of them, Professor John Milne, F.R.S., now residing on the Isle of Wight, then Professor of Geology in the School of Engineering, exhibited a zeal and enthusiasm together with untiring patience and fertility of resource beyond all others, and mostly through his efforts the 'Seismological Society of Japan' was organized. In its organization and maintenance the foreign professors received the hearty cooperation of the Japanese officials in the University and out of it. For several years the society issued annual volumes of Proceedings, the great value of which has been everywhere recognized. The gradual and finally almost complete withdrawal of foreigners from the educational work of the country resulted at last in the suspension of the active work of the society, but happily this did not occur before the Japanese had come to realize fully the importance of the work it had done, and, indeed, not until a number of their own young men had been fully trained to carry that work on.

In 1891 official interest in seismology took definite form in the passage of a vote by the Chamber of Peers or House of Lords, upon the initiative of one of its members Dr. Dairoku Kikuchi, now President of the Imperial University of Japan. By a large majority the Cabinet was urged to appoint an 'Earthquake Investigation Committee,' and on June 25, 1892, an Imperial Ordinance was promulgated establishing such a Commission and naming its members. Its duties were defined in a general way in this Ordinance and the payment to its members of a small annual salary was authorized.

The Committee prepared a very elaborate and comprehensive scheme of work which it has followed pretty closely up to the present. The President is Dr. Kikuchi, and Dr. Omori, of the Faculty of Sciences of the Imperial University, is Secretary. There are nearly thirty members, including professors of pure and applied sciences in the University, engineers, architects, etc.

It has been the wise practice of the Committee to publish its principal proceedings and most important papers in foreign languages and of the two under review No. 3 is mostly in the French language and No. 4 is in English.

One of the principal objects of the Committee is to consider the practical aspects of seismology with a view to a lessening of the loss of life,

damage to buildings and other structures, as far as may be found possible, so that much attention has been given to studies of resistance of materials of construction and to the effect of actual earthquakes upon existing structures of various kinds. No. 3 consists, in the main, of an account of a most elaborate and interesting experimental investigation of some of the more important physical properties of bricks, and briquettes of cement, mortar, etc., especial attention being given to those qualities which give strength and stability against seismic disturbance. This report is by S. Tanabe, a member of the Committee, and is a valuable contribution to our knowledge of the subject.

There is also, in the same volume, a short description by B. Mano of a machine by which a platform or 'shaking table' is made to oscillate as it would during the passage of a series of seismic waves, the horizontal and vertical motions being produced independently, each capable of adjustment as to amplitude and frequency, so that almost any kind of disturbance may be imitated, except minute earth 'tremors.' The motive power consists of two steam engines, and as many as 270 oscillations per minute may be maintained. There is also a brief note on the damage suffered by tall chimneys in the earthquake of June, 1894, and in that of October, 1893. In the case of the latter 230 chimneys in all were examined, ranging in height from 30 feet to 150 feet. Of these 53 suffered serious injury, the highest percentage being for those between 60 feet and 80 feet high. The volume closes with a paper in English on 'The Scope of the Volcanological Survey in Japan,' by Dr. B. Koto, member of the Committee, who has undertaken to study the geological aspects of the seismic problem. For the great majority of earthquakes the author rejects the volcanistic hypothesis and adopts the *tectonic*, believing that seismic disturbances are intimately related to the process of mountain building.

No. 4 begins with a condensed statement on the 'Construction of Earthquake-proof Wooden Buildings.' Although very brief, this paper is of great interest, and as nearly all houses in Japan are built of wood it must prove to be of great practical value. Rules for the making of joints, the construction of frame work and especially of roof framing are given with sufficient detail and clearness (aided by numerous illustrations), and particular emphasis is placed on the character of the foundation. Even ordinarily constructed wooden houses are damaged less by earthquake disturbances than structures of brick or stone, and when built according to the rules and suggestions given in this paper they will be generally immune except during unusually violent shocks. The worst part of an ordinary Japanese house, from the seismic standpoint, is the heavy tile roof, and the importance of making the roof as light as possible, and of having the tile securely fastened, is dwelt upon in this compendium. The use of iron plates and straps, with bolts, in the formation of joints is strongly advised. It may be interesting to note here that the new palace for the use of the Prince Imperial is to be a modern 'structural steel' affair, the material having been obtained in this country, and in the structural plans, made by American architects, especial care has been exercised to provide against damage by earthquake. By the use of numerous cross-braces and 'ties' it is made to resemble somewhat a huge steel basket which, although it may, and indeed, should be capable of a little elastic yielding, can never be seriously injured in any imaginable seismic disturbance.

Anent the generally damaging effect of earthquakes upon brick buildings Dr. F. Omori discusses the records of a number of disturbances as shown by two of Professor Ewing's horizontal pendulum seismographs, one of which was set up on a wall of a large brick building, known as the Engineering College, and the other on the ground near by. Ten earthquakes were thus observed and recorded, none being very strong. The results appear to show that in comparatively long period oscillations, that is to say those somewhat above .5 second, there was no noticeable difference in amplitude between those of the second story of the brick building and those of the ground, while with quick period motions the movement was greater on the wall of the building than on the ground, the average amplitude of the former being double that of the latter. Omori

calls attention to the fact that injury to brick buildings by earthquakes is nearly always much greater in the upper stories than in the lower, and he illustrates this by photographs of the condition after the great earthquake of 1891 of the Aichi Cotton Mill and the Post and Telegraph Office, both at Nagoya. The Charleston earthquake in 1886 afforded many examples of this.

Omori furnishes two very interesting notes on the great earthquakes of 1891 and 1894. These are the most violent disturbances that Japan has suffered in recent years, and that of October 28, 1891, was probably at least equal in intensity to any other earthquake of which we have authentic record. Its greatest activity was displayed in the provinces of Mino and Owari. The land area disturbed was about 250,000 square kilometers, and as the mean radius of propagation was about 520 kilometers the total shaken area was about double the area of the whole empire. The total number of people killed was 7,000, and 80,000 houses were entirely destroyed. The fact that only one life was lost for every 11 houses destroyed illustrates (when compared with the effects of earthquakes in brick- and stone-building countries) the greater safety of wooden houses which, even when destroyed, afford ample warning and time to enable their inmates to escape.

The actual motion in this earthquake was nowhere satisfactorily recorded on seismographs, but Omori has made up for this lack as far as possible by the observation and calculation of a large number of overturned stone lanterns and tomb stones, noting as well those not overturned. The horizontal acceleration necessary to overturn is calculated by West's formula which is very simple and unquestionably very nearly correct under the conditions considered.

It is

$$a = \frac{x}{y} g$$

in which g is the acceleration due to gravity, and x and y the horizontal and vertical coordinates of the center of gravity of the column, the origin being the edge about which overturning takes place. It is assumed that the motion is entirely horizontal which introduces no sensible error except for points, very near the epifocus. Results are computed for about sixty points in the disturbed area, and in several instances a horizontal acceleration of over 400 centimeters per second, is shown. The seismograph at Nagoya, one of the principal points shows that the complete period of the principal vibrations was about 1.3 seconds, and as the maximum acceleration there was 260 cm., it follows that the range or amplitude of vibration of the earth particle was between 23 cm. and 24 cm.

The earthquake of June 20, 1894, although the most violent experienced in the Tokyo district since 1855, was much less strong than that of the Mino-Owari district referred to above. Twenty-six persons were killed and 171 were wounded. Fortunately the disturbance was very satisfactorily recorded by a strong-motion seismograph at the Seismological Observatory in Tokyo. The actual amplitude of horizontal motion was 7.3 cm., and the maximum acceleration was about 100 cm. per second. In the greater shock of 1891 this was probably not less than 1,000 cm. per sec. per sec.—being a little greater than the acceleration due to gravity.

Dr. H. Nagaoka has a very interesting paper on the experimental determination of the elastic constants of rocks, leading to important conclusions relating to the velocity of seismic waves. From observations made in Italy and also in Japan, Omori has concluded that the velocity of the first tremor is generally as high as 13 kilometers per second, which is surprisingly great, the principal shocks usually showing a speed of 3 kilometers to 4 kilometers per second.

Nagaoka discusses the conditions under which the very high velocities may occur, and one cannot avoid being impressed with the great value of earthquake observations as a means of ascertaining the nature and conditions of the interior of the earth.

The greatest part of No. 4 consists of an account, by Omori, of an elaborate series of 'Experimental Studies upon Fracturing and Overturning Columns,' and this is not only one of the most interesting, but perhaps the most important paper in the whole series. In this investigation the 'shaking table' already referred to was made use of and columns of considerable dimensions and various materials were used. Many were of dimensions equal to those

of the stone lanterns and tombstones made use of in computing the intensity of the Mino-Owari earthquake. The accelerations necessary to overturn were also calculated by West's formula, and it is surprising to see how closely they accord with those obtained from the graphic record of the 'shaking table.'

Because the contents of these volumes are made up of carefully conducted observations of actual and very strong earthquakes, for the first time recorded by means of satisfactory instruments, together with elaborate experimental investigations of important related phenomena, and because all these results are fully discussed with remarkable skill and keen scientific insight, it is, perhaps, not too much to say that they constitute the most valuable contributions yet made to the literature of seismology.

Even those who know the men who are doing this work, through familiar association and often close personal relations, cannot avoid a feeling of astonishment at the extraordinary performances of a people whose contact with the world at large has been only that of the present generation, and with whom the so-called civilized nations have been strangely and unreasonably unwilling to treat on a basis of equality until within three or four years. When I reflect that seismology is only one of the many sciences in which in original research the Japanese are well in the front rank, and this, too, without the inspiring example of an ancestral Galileo, Newton, La Place, Humboldt or Franklin, I wish to do figuratively what I have done many times actually—I take off my hat to an oriental nation that in peace or in war need ask no odds of Europe or America.

T. C. MENDENHALL.

Rapports présenté au Congrès International de Mécanique appliquée; Exposition Universelle de 1900. Tome I. CH. DUNOD, Editeur. Paris. 1900. 8vo. Pp. 546.

The various congresses of the Paris Exposition of 1900 are now bringing out their published papers and discussions, and the royal octavo volumes of the Congress of Applied Mechanics are finely illustrative of the character of the work performed at these conventions and of the manner in which it is to be published. Of the innumerable books printed relating to the Exposition, these are the most valuable and, to the serious student of that great cyclopedia, most interesting. The 'questions' discussed in Vol. I. are nine in number: 'Organization of Works'; 'Organization of Mechanical Laboratories'; 'Mechanical Applications of Electricity'; 'Hoisting Apparatus'; 'Hydraulic Motors'; 'Sectional Boilers'; 'High-speed Engines'; 'Heat Motors'; 'Automobilisme.'

The first topic is discussed by M. Touissant, who presents a study of the manufacturing establishment generally, and Mr. Dickie, who gives a most interesting account of the organization and administration of the Union Iron Works of San Francisco, the birthplace of the famous battleship *Oregon*, and the source of innumerable steamships, steam-engines and pumping and winding engines, and of mining and manufacturing machinery in enormous amount. M. Boulvin discusses the organization of mechanical laboratories, and his valuable paper is introductory to that of Dwelshauvers, who describes that of the University of Liège, organized by him after years of struggle and strife with the ultra-conservative administration of the University and the Government. The evolution of the mechanical laboratory in America, as an element of technical instruction, is described by Thurston and includes papers by a number of representatives of engineering schools in the United States, giving accounts of an equal number of the most extensive and interesting laboratories of that class in our country. The development of the laboratory of applied mechanics and its accessories as a means of instruction, primarily, and as an item in the equipment of the technical school and as an essential element of the curriculum, was first effected satisfactorily in the United States. The European schools are now coming to the same plan in rapidly increasing numbers, often modeling after our own in both equipment and methods of employment. Another instructive division of this subject is discussed by Commandant Mengen, who tells of the organization and the details of equipment of the laboratory of the ordnance department of the French army, which is very extensive

and complete and is evidently conducted in a modern and fruitful manner.

The third 'question' includes a paper by Dr. Kennelly, describing mechanical applications of electricity, especially as observed in the United States. Messrs. Delmas and Henry discuss the use of the current in hoisting machinery and in the establishments of public works departments. M. Bassères discusses the fourth question and especially the work of the 'Compagnie des Fives-Lillie.' Hydraulic motors, as constructed in Switzerland, the home of that form of prime mover, 1889–1900, are reported upon by M. Prazill. M. Rateau writes of their theory and construction as illustrated by contemporary practice in general.

Dr. W. F. Durand takes up the sixth topic and gives an account, complete and exact, of the water-tube boilers employed in the United States, and M. Brillié also discusses the 'chaudieres a petits éléments,' their classification, efficiency, operation, with characteristic thoroughness. MM. Lefer and Lecornu write of high-speed engines and of regulators, the former including the ancient Greek type, just revived, the steam-turbine. 'Thermic Motors,' apparently only intending to include the gas-engines in the class, are the subject of valuable papers by MM. Diesel, who reports on his own invention and construction; by Mr. Donkin, who discusses those employing the waste gases of the blast furnace; and by M. Witz, the well known authority on that class of motor, who tells of gas-engines of large power employed in metallurgy. The final discussion in this volume is that of 'automobilisme,' by MM. Rochet, Cuénot and Mesnager.

All the papers here published have special value in their several departments of applied science and some of them are extremely important. The contributors to the volume are usually French writers and practitioners of authority; a few are American, and we recognize the name of but one German in the list. The German government took a leading part in the Exposition and German exhibitors abounded, as did German visitors; but the scientific men of Germany, in this department, at least, seem to have held aloof.

The book is a fine sample of the style and finish of the French official document. In paper, type and finish, and illustration, while not what a French critic would consider illustrative of a high class of bookmaking, it is, for its place and purpose, most excellent. In many cases of condensation and of abstracting, on the part of the editors, as especially in the case of the descriptions of American mechanical laboratories, where the original contained very extensive and very extensively illustrated details, the necessary work of merciless condensation has been, in the main, very well done. The translations from the English into the French are, so far as a first rapid survey would indicate, excellently performed. The collection will have great and permanent value to the engineer and to the professor of engineering, as well as to all having interest in these divisions of applied mechanics.

R. H. Thurston.

The Antarctic Regions. By Dr. Karl Fricker. Translated by A. Sonnenschein. New York, The Macmillan Company. 1900. Pp. xii + 292. With many maps and illustrations. Price, $3.00.

In view of the widely extended interest in the Antarctic region at the present time, it would seem as though it would almost be unnecessary to say that this was a timely production. It is, however, not the only requisite of a book that it is timely. Its substance should be of a high character and its form of statement should be clear. In this particular case, the historical portion of the work is good, but its character is marred by too great condensation. This fact alone would make it a poor book to put in the hands of the general reader, who is looking for pleasure as well as for information. Even if the original work was intended for the scientific man, the translator should have had tact enough to recognize the fact that it was not at all necessary to follow the German construction of the sentences too closely. A good translation should take some account of the spirit of the language into which the work is to be rendered, and not make its perusal a burden by the introduction of too many parenthetical sentences. Of course in such a work as this much new information is not to be expected, and the major portion of

the book is given over to a historical summary of the various voyages to the South Polar region. But that is no reason for closing this section of the book with the following sentence (p. 131):

"This survey indicates what parts of the Antarctic regions have principally been visited, and sums up how much or how little has been achieved by each attempt. It will be the aim of the subsequent pages to gather into a whole the results of all these explorations so far as their fragmentary nature renders such a task possible."

This portion of the book is followed by a description of the 'conformation of the surface and geological structure,' which would be a very acceptable piece of work were it not for the cumbersome English sentences which defy all attempts to parse them.

A splendid opportunity to offer a summary of our knowledge of the climate, the structure of the ice, the fauna and flora is simply annihilated by such sentences as the following (p. 250): 'The non-melting of the snow is of necessity accompanied by a change in its transformation.'

Again, scientific men do not usually speak of a species of animals being 'extirpated,' as they are said to be on pages 270 and 273.

The maps and charts are, however, the redeeming features of the book. They form a very interesting collection of illustrations and are worthy of a better fate than burial in such ponderous and heavy verbiage.

It is also to be regretted that in giving a list of books, articles and maps upon this subject, no attempt was made to make the list as nearly complete as possible. In these days of careful bibliographical work the preparation of such a list would have been a comparatively easy task. Furthermore, a labor of this character would have been very much appreciated by the scientific world, and it is a pity that it was not done.

By what has been said above, it is not intended to produce the impression that the book is without merits. It will be a useful compend for a person who desires to become acquainted with the leading facts in connection with Antarctic investigations, but it will never be a book of popular interest. In the scientific summaries too little has been given to satisfy the scientific man, and it is therefore evident that there is still an opportunity left for a book which will satisfy these conditions.

WILLIAM LIBBEY.

Physiology for the Laboratory. By BERTHA MILLARD BROWN. Boston, Ginn & Co. 1900. Pp. viii + 167.

A Syllabus of Elementary Physiology with References and Laboratory Exercises. By ULYSSES O. COX. Mankato, Minn., Free Press Printing Co. Pp. viii + 167.

If one were to judge by the number of books on 'Practical Physiology' that appear yearly, it would seem that the long-hoped-for day had come in which Physiology had become a laboratory study in all academic grades from the grammar school to the university. Even if it fulfills the ideal of its author only, each book in this field, if well done, is to be welcomed, for it means at least an attempt in the right direction.

Of the two books now before us Miss Brown's is the more modest. In less than 150 pages there are given the essential experiments in a course in Vertebrate Physiology, presumably for the high school or normal school. A chapter on the cell and one on the bacteria are added. The matter is in large part purely physiological, but the dissection of the various organs is included. Vivisection is excluded except the slight amount that is involved in a study of reflex action in the brainless frog. The directions simply point the way, and the chosen ground is well covered. A few corrections should be made: The chromosomes are said to 'be scattered through the protoplasm'; epidermis is 'the outer, dead skin'; the expanded portion of the external ear is misnamed the 'concha,' while the reflex character of the knee-jerk is settled by requiring the student to trace the course of the nerve impulse.

The book by Mr. Cox consists of a syllabus with references to reading, and a series of laboratory exercises. The syllabus is a detailed but crudely expressed classification of the conventional subject-matter of Physiology, of which students could make little use. The references are chiefly to well-known American and English

text-books, most of which are good but some of which are sadly out of date. The laboratory exercises partially cover the conventional elementary ground, but are inferior to those of Miss Brown and of other authors. Unfortunately the book is marred by slovenly English, colloquial expressions and typographical errors.

FREDERIC S. LEE.

Physiology, illustrated by Experiment. By BUEL P. COLTON. Boston, D. C. Heath & Co. 1900. Pp. xiii + 386.

This book is intended as a 'Briefer Course' of Mr. Colton's 'Physiology, Experimental and Descriptive.' As an elementary text-book for secondary schools it can be recommended. It contains an unusually large amount of matter, concisely, briefly, and upon the whole attractively presented. It is preeminently physiological and hygienic as distinguished from anatomical. Its language is not overburdened with technicalities. Its directions for practical work are limited, but this is excusable in view of the many satisfactory laboratory books now in existence. Most of its figures and diagrams are excellent.

The treatment of the subject of alcohol, while fairly moderate as compared with that of some writers of text-books, is somewhat intemperate in its use of adjectives. At the beginning of the chapter devoted to this subject the bald statement is made that 'alcohol is not a food.' At the close of the chapter it is allowed, on the authority of well-known quoted writers, that 'technically it may be called a food.'

FREDERIC S. LEE.

FOLK-LORE IN BORNEO.

DR. WILLIAM HENRY FURNESS 3d, had privately printed an attractive little volume called 'Folk-lore in Borneo: A Sketch,' in which is given a brief report of an ethnological field that has acquired a new interest because of the recent discoveries made in the group of islands to which Borneo belongs. The influence of a tropical environment is noted by the author in the Kayan myth of creation, which he narrates as a 'purely Bornean' product, and contrasts it with the Dyak account of the genesis of the race, wherein he discerns Malay influence. Among the interesting pages of the book are those which tell of head-hunting, 'the one ruling passion of the people.' The tradition of its origin is given, and the author thoughtfully remarks: "It is not unfair to infer from this tradition that they have a crude, germinal sense of the barbarity of their actions, in so far as they think it necessary to invent an excuse to palliate that savage love of trophy-hunting which seems inborn in mankind." And he points out how the native beliefs concerning the five peculiar regions in 'the land of departed spirits' tends to conserve the practice of the head-hunting 'rite.' Among the many interesting subjects touched upon are the connection between the Pleiades and agriculture; the omen birds and the devices the people practice to avert bad luck; the function of fire as a 'go-between of man and the birds'; and the glimpses of a river cult among these natives. The illustrations really illustrate the text; they are admirably selected, and the pictures of old and young, men and women, inspire confidence as types, as they are without exaggerated peculiarities. The book is a welcome addition to the literature of folk-lore.

A. C. F.

DISCUSSION AND CORRESPONDENCE.

NEWSPAPER SCIENCE.

TO THE EDITOR OF SCIENCE: I have had so much satisfaction in the review and criticism recently published in SCIENCE, of Mr. Tesla's magazine article on 'Human Energy' that I cannot avoid making public acknowledgment of my appreciation of its justice and timeliness, especially the latter. Is it not the imperative duty of men of science to do what the author of this review has done, more frequently than they have during the past ten years?

Within this decade there has been an enormous decrease in the cost of publication and especially in the expense of illustration, and this has brought about a deluge of reading matter of such infinite variety and general worthlessness that the formation of a society for its systematic suppression is worthy of serious consideration. With the daily newspapers it has been distinctly an era of sensationalism.

A reporter for a daily paper recently de-

clared that he was required by his chief to 'furnish at least two sensations a week.' Nearly all the more respectable and conservative magazines have yielded somewhat to this demand. The general reading public has recognized in an indistinct and uncertain way that much that is wonderful in this 'wonderful century' is due to scientific discovery, and it is apparently hungry for easy exposition of scientific work. It seems to like, at any rate it is largely fed upon, science of the 'head-line' variety, and those who can furnish this sort are in great demand. Unfortunately there are a few men, fortunately not many, who have done and are doing really excellent scientific work who are ready to cater to this morbid appetite, and there are many others, merely 'hack' writers with neither knowledge or reputation, who find it easy to imitate them. The result tends to dull the scientific sense and corrupt the judgment of the great majority of readers. What we see in print concerning what we do not understand we almost invariably accept as true unless it violently opposes our prejudices or accepted theories, and the general public, therefore, is in a very receptive mood towards announcements of scientific discoveries and accomplishments. That this is taken advantage of to reach the purse of the public no one can deny, and it is impossible not to find certain very respectable and otherwise conservative journals largely responsible for losses of thousands of dollars by comparatively poor people through stock subscriptions in schemes believed to be backed by scientific men. It is no valid defense to say that the editors of these journals were imposed upon, for if they were they need not have been. Other journals, including some daily papers, know very well how to avoid such imposition and have the courage to do it. It appears to be accepted as a fundamental principle of what is called 'journalism' in these days that any one who is gifted with a little facility in writing, a far-reaching imagination and a conscience without elastic limit may be properly 'assigned' to prepare an article on any subject whatever, and thus we are treated to weekly or monthly essays by one author covering, in fact sometimes rather more than covering, in a few months the whole area of human knowledge. Perhaps they, too, have their orders to produce a given number of 'sensations' in a given time.

Among many other evils growing out of what may be called 'Newspaper Science' not the least is the manufacturing and maintaining of false reputations. The constant appearance of a name in connection with the development of a given art, science, discovery or invention makes an impression which it is difficult to destroy, and this is true even among the most intelligent classes. To find who is really and truly eminent in any field of human activity one must go to the specialists in that field. The popular verdict is more than likely to be wrong because it is based on fictitious, newspaper-created renown. Is there not, indeed, some danger that in spite of the carefully selected and altogether able jury, the newly created roll of American honor may, in certain cases and for the lack of this appeal to specialists, become a Hall of Notoriety rather than Fame? The selection of S. F. B. Morse for a place therein must have been due to the general belief among the jurors that he was the inventor of the electro-magnetic telegraph. Yet it was long since proved beyond dispute that his share in that invention was among the least of the many who contributed to make the telegraph possible, and that he justly deserves only a relatively very small share of the honor belonging thereto.

T. C. M.

THE DATE OF PUBLICATION OF BREWSTER'S AMERICAN EDITION OF THE EDINBURGH ENCYCLOPÆDIA.

IN commenting on a recent paper by Mr. J. A. G. Rehn (*Amer. Nat.*, XXIV., p. 575), Dr. J. A. Allen states (*Bull. Amer. Mus. Nat. Hist.*, XIII., p. 186) that the reference to "Brewster's American Edition, Edinburgh Encyclopædia, Vol. XII., Part II., p. 505, 1819," given by Mr. Rehn, "is erroneous as to date, and misleading as to the title of the work cited."

There is nothing whatever in Mr. Rehn's statement to warrant the idea that he had taken the reference at second hand, as Dr. Allen seems to have inferred, and as a matter of fact his reference is perfectly correct.

As Dr. Allen's positive statement that the

work dates from 1832 is calculated to mislead others, it seems desirable to call attention to the facts in the case.

The earliest American edition of the work, entitled 'The American Edition of the New Edinburgh Encyclopædia,' was published at Philadelphia by Edw. Parker and Jos. Delaplaine, Edw. Parker, and Jos. Parker (the firm changing twice apparently), in 18 volumes, each in two parts, making 36 volumes in all. Each has the full title printed on the outside cover, together with the date of publication, which ranges from 1812 to 1831.

This edition was probably printed directly from the Edinburgh one, as fast as the parts came out. Of this, however, I am not sure, as I have not the dates of the latter at hand.

After this publication was finished, extra copies, which were apparently struck off from the same type, as they are absolutely identical, were bound up in 18 volumes with a new title page: 'The Edinburgh Encyclopædia conducted by David Brewster, first American edition,' all the volumes bearing date of 1832.

The statement 'first American edition' probably misled Dr. Allen, though except for the title page and introduction, this edition seems to be identical with the real first American edition of 1812–1831. Both 'editions' are in the library of the Academy of Natural Sciences of Philadelphia.

Witmer Stone.

THE SPENCER-TOLLES FUND OF THE AMERICAN MICROSCOPICAL SOCIETY.

To the Editor of Science: At the annual meeting of the American Microscopical Society, held in New York City during the last week in June, the especial attention of the Society was directed toward the Spencer-Tolles fund. As many are unfamiliar with the movement, permit us to state its history briefly as follows:

After the death of Charles A. Spencer in 1881 and of Robert B. Tolles a few years later, it was deemed fitting that a sum should be raised to provide a proper memorial to the father of American microscopy and his distinguished pupil, as a tribute due their services to the scientific world. The first notice of the movement was sufficient to bring, unsolicited, from the Royal Microscopical Society of London a contribution for this purpose. Additional sums subscribed by the members and others, together with the natural increase under the careful management of the Custodian, have brought the sum to a total at date of $756. The recent death of Herbert R. Spencer, the last of the three famous American workers, to whose efforts toward the perfecting of microscopic objectives the entire scientific world is so deeply indebted, serves as the immediate impulse of this movement toward the enlargement of the fund to a point at which its income may be sufficient to encourage in some way the advancement of science. It is accordingly desired that this tribute to the Spencers, father and son, and to their co-worker, Mr. Tolles, should be increased at once to the sum of at least $1,200, in order that the income therefrom may be offered each year under proper conditions as a reward for or assistance toward some scientific work or investigation of suitable character.

To this end the undersigned were appointed by the Society to secure cooperation in the effort to increase the fund, and to solicit contributions toward that end. We believe that the object will appeal to every one who is called upon to use the microscope in any capacity whatever, and contributions will be welcomed from all. Remittance should be made to Mr. Magnus Pflaum, Custodian of the Spencer-Tolles Fund, Bakewell Law Building, Pittsburg, Pa., who will at once return a proper receipt for the same.

For the American Microscopical Society.

Committee:

Henry B. Ward, The University of Nebraska, Lincoln.

Adolph Feiel, 520 East Main St., Columbus, Ohio.

Henry R. Howland, 217 Sumner St., Buffalo, N. Y.

Custodian:

Magnus Pflaum, Bakewell Law Building, Pittsburg, Pa.

SOCIETIES AND ACADEMIES.

TORREY BOTANICAL CLUB, OCTOBER 9, 1900.

The scientific program consisted of reports of summer work.

Mr. Harper reported collections in Georgia during three and a half months, traversing all the geological formations from the mountains to the sea, and collecting 754 numbers.

Dr. Rydberg reported two months spent in southern Colorado, with several new species; among them an interesting cactus from elevation of 8,000 feet in the Bitter Root mountains, now growing at the Botanic Gardens.

Dr. Howe reported nine weeks spent in collecting marine algæ at three very different stations, Bermuda, Martha's Vineyard (at Edgartown), and at Seguin Island, near the mouth of the Kennebec, an island four miles from the mainland, of about 150° elevation, its only inhabitants the three lightkeepers and families. Dr. Howe discussed the Bermuda flora in the light of the *Challenger* report, which recognizes 326 species, of which 144 are indigenous (in 109 genera and 50 families); out of the 144, 109 occur in the southeastern United States and 108 in the West Indies. The Bermuda vegetation is essentially West Indian in character, and includes only eight endemic species. Among the few found also at New York are *Osmunda regalis* and *cinnamomea*, *Woodwardia Virginica*, *Solidago sempervirens* and *Typha augustifolia*. Practically the only trees are the Palmetto and the Bermudian Cedar, the latter 20 to 50 feet high, and only one or two feet thick, though some old shells are five feet. The oleander is naturalized and in some quarters covered the whole landscape with bloom. Because of the practical absence of frost, tropical trees are acclimated with surprising success. The coffee tree has run wild in the sink-holes. About 25 ferns were known and eight Musci and six Hepaticæ had been already observed. There is nowhere any brook, and only one moss and one hepatica are common; the others are in the Devonshire marsh and the sink-holes of the Walsingham region. These are open caves 30 or 40 feet deep, with more moisture and shade and less wind, and therefore showing quite a different flora. There Dr. Howe discovered as many as 15 Hepaticæ. He also greatly increased the number of the marine algæ beyond the 132 of the *Challenger* report. The marine flora seems at first scanty on account of the absence of *Fucus* and *Ascophyllum*, but proves to be varied and interesting. It is practically that of southern Florida and the West Indies.

Dr. MacDougal reported work in northern Idaho in the Priest River basin which had perhaps never been visited by a botanist before. There was frost nearly every night. The tangled wildwood could not be penetrated more than four miles a day, except as it is entered by meadows stretching back from the lake. Beaver-dams a quarter mile long cross these meadows and convert the upper portions into sedgy marshes. A colony of beavers was active within 400 yards of his camp. Great stretches of *Drosera* carpet the marshes. Interesting plants were collected to 325 numbers.

Mrs. Britton sent in a brief report of her discovery of the protonema of Schizaea, observed as a green mat of thread-like bodies on the ground. On bringing them to the Botanic Gardens and cultivating them, she proved their development into Schizaea, and found the branching protonema to bear 2 to 15 flask-like archegonia on basal parts and a number of globose antheridia toward the apex. Description will follow in the November *Bulletin*. Dr. MacDougal remarked upon his observation of a mycorhizal association of a fungus in enlarged cells of this protonema. A similar association has been seen in the prothallus of Botrychium.

Professor Lloyd reported upon work on the Gulf coast begun after the close of his classes at the Columbia University summer school. Professor Lloyd and Professor Tracy procured a barge at Biloxi, Miss., by which they explored the flora of the islands of the Mississippi Sound and of the delta proper. It was necessary to sail for miles in two feet of water, occasionally jumping out to push. Always a furrow of mud followed in their wake. The islands bear a pine-barren and a sand-dune flora, with masses of *Pinguicula* and *Drosera*. The island surfaces are flat and form remnants of the tertiary Mississippi delta; they average only two feet above water, with a ridge a foot higher on the seaward side, composed of shell-fragments and continually shifted inward by the wind, the waves meanwhile gnawing off the seaward edge at the same rate.

Professor Burgess reported his continued ob-

servations on certain asters at stations near Lake Erie, Boston, the White Mountains, New York City, etc., at each of which he has kept certain varying species under scrutiny for some years, to determine their range of variation in nature under unchanged environment.

Professor Underwood reported herbarium work at Kew, the British Museum, and Paris, with particular reference to the herbarium of Cosson which is very rich in ferns, especially of South America and the West Indies. An interesting week was given to a trip to Biarritz, Spain, and the Landes, with views of the turpentine industry now flourishing among pine forests of the Landes originally planted as a protection from the sand-dunes. These pines average about ten inches in diameter. Maize was seen cultivated in the Basque provinces and to Bordeaux, the tops being cut off to favor the ripening of the ears, as in our South.

Edward S. Burgess,
Secretary.

NOTES ON OCEANOGRAPHY.

THE DEEPEST FIORD ON THE LABRADOR COAST.

An expedition on the schooner *Brave* spent the past summer exploring the northeastern coast of Labrador. Twenty-one soundings in Nachvak Bay sufficed to show that it is a typical fiord. The line of dangerous reefs two miles to seaward from the mouth of the bay belongs to a rock-sill which bars off the inlet from the deeper water of the Atlantic. Already at the mouth the depth is 107 fathoms. Six miles to westward, in the axis of the bay, the depth is 110 fathoms; for the next six miles it averages 100 fathoms. Then the bottom rapidly shoals to a narrow bar covered by no more than 18 fathoms. On account of its continuity with a projecting spur of bed rock on each side, it was concluded that the bar is composed of the same material. From the summit of this submerged ridge a second steep slope leads to a depth of 80 fathoms which persists to a point opposite the Hudson Bay Company's Post. Twenty miles from the mouth, a second bar of similar composition gave only 15 fathoms; it is flanked by depths of 60 fathoms. The bay has two branches, each heading about 25 miles from the bay-mouth, and is from one to two miles wide. Precipitous cliffs from 2,000 to 3,400 feet high appear in the profile of the U-shaped cross-section which is the rule in all parts of the bay. The deepest sounding recorded on the Admiralty charts for the bays of this coast is 100 fathoms in Hamilton Inlet.

The temperatures on August 30th were: at 110 fathoms, —1°.7 C. (29° F.); at 50 fathoms, —1°.4 C. (29°.4 F.); at 20 fathoms —1°.2 C. (29°.9 F.); at the surface, + 6°.8 C. (44°.3 F.). The temperature of the water from 20 fathoms downward to 50 fathoms is colder than the water at corresponding depths in the open Atlantic outside. The bottom temperature is very close to that characteristic of the envelope of brackish water formed about a piece of sea-ice melting in normal open-Atlantic water. Drift-ice finally left Nachvak Bay this year as late as the first week in July.

DRIFT-ICE AND THE THEORY OF OCEAN CURRENTS.

The extraordinary smoothness of the sea covered by drift ice, even when the pans are widely spaced, is truly astonishing to one making his first voyage in such waters. His sailing ship may be favored with a fresh breeze and yet the ocean surface be quite level, save for the minute rippling characteristic of a small pond ruffled by a summer breeze; ground-swell does not exist. It is a matter of common knowledge among the fishermen of the Atlantic Labrador coast that the Labrador current, or 'tide,' as they invariably express it, often shows high velocity, although its surface, for a length of a thousand miles and a breadth of from one hundred to three hundred miles, is covered with loose pan-ice. At such times, the wind is, or has just been, strong and from a northerly quarter. We are justified in believing that the pans act as the sails which, in ice-free waters are represented by wind-waves. Floes and pans project above the surface from one to twenty feet or more. They may be expected to exert a coercive force on the film of relatively fresh water derived from the melting of the ice in contact with the heavier salt water beneath. According with the behavior of such 'dead water,' as described by Nansen and others, the light surface layer will tend to

move *en masse* and in the direction of common pull exercised by the wind-driven masses of ice. By reason of friction the motion will be communicated to lower layers of the sea. This cause of surface currents is of importance to the theory of movement of those polar waters which, for several months after the winter ice begins to break up, are free from larger wind-waves. Deprived of its chief sails, the Labrador current, always sensitive to wind conditions and at times subject to temporary reversal with contrary winds, yet preserves and perhaps exceeds, during the period of ice-drift, the average velocity of current-flow for the year.

NOMENCLATURE OF TERMS USED IN ICE NAVIGATION.

A USEFUL 'list of some of the terms used in ice navigation by whalers, sealers and others' has been prepared by Commander William Wakeham, of the Canadian Marine and Fisheries (Report of the Expedition to Hudson Bay and Cumberland Gulf in the steamship *Diana*, 1897, Ottawa, 1898). Among the terms, the following are here noted with their definitions as expressed by Commander Wakeham:

Floe—A large mass of floating ice.

Pan—A small floe or small piece; one that can be forced aside or slewed.

A field—A large body of ice that may be seen around.

Land floe—Ice frozen ast to the shore.

Collar ice—Is the margin of ice frozen fast to an island or shore, presenting an abrupt wall against which the floating ice rises and falls with the tide.

Growler—Is a more or less washed and rounded lump of ice which rolls about in the water, formed from broken up bergs or detached pieces of heavy old Arctic floe ice. [So called from the sound of heavy churning as the swell breaks at the undercut portion of the pan.]

Packed ice—Are small pieces closed together and held by the pressure of ice and currents.

Batture—Rafted ice [described on page 12 of the report].

Pressure ridge—Is the ridge or wall thrown up while the ice has rafted.

Slack ice—Is detached, so that it may be worked through. Ice is said to be slacking when it begins to be open so as to be navigable.

Running abroad—Ice is said to be running abroad when it opens out or slacks away so as to be navigable.

A nip—Ice is said to be nipping when it begins to close by reason of the action of winds or currents, so as to prevent the passage of a vessel.

Calving—Ice is calving when the small pieces break off from the bottom and rise to the surface of the water.

Slob—Is snow afloat and forming into ice.

Sish—Is thin young new ice, just formed in thin sheets.

Lolly—Is loose new ice.

Porridge ice—Is small, finely ground up ice.

Rafting—Occurs when two pans meet by force either by the action of wind or currents; the edges are broken off and either rise on top of or pass under the body of the pans.

A lead—Is a strip of navigable water opening into the pack.

Slatches—Are considerable pools of open water in the ice.

Swatch—Is a small pool of open water in the ice.

Wash—Is the sound of the sea breaking against ice.

Rote—Newfoundland term for wash.

Water sky—Is a dark or bluish appearance of the sky indicating open water beyond the pack.

REGINALD A. DALY.
HARVARD UNIVERSITY.

AMERICAN ELECTRICIANS IN LONDON.

THE Central London Railway, the 'Electric Underground,' of London, the 'two-penny tube,' is one of the most important and, in some respects, far the most remarkable example of the work of the American electrician and engineer in Europe, perhaps in the world. It is a subterranean road running from Shepard's Bush, at the west, to the Bank in the city. It was opened last June by the Prince of Wales. Its 5¾ miles of route have seen the expenditure of about $15,500,000 during the four years of construction, and many minor bits of work remain to be performed. The original engineer of the work was the late Mr. T. H. Greathead. It was found necessary to come to the United States to secure its exceptionally large and powerful machinery and motive power. It is, in fact, an American electric railway in operation in London, the center of the brains and business of Great Britain. In one respect at least, however, it is novel as to its roadbed:

it is an 'undulating railway,' its stations are all set on the crest of gradients rising from either side, illustrating the plan proposed in Robert Stephenson's day by Badnall with the published approval of that great engineer.* This arrangement is perfectly feasible whereas here, the stops are all made at precisely the same points and with practically similar intermediate speed of trains. It insures gain in operation by the utilization of the stored energy of the train at a stop, instead of its waste by the use of the brake. Leaving the station, the descent is utilized in securing the required acceleration, thus again saving power. The gradients are 1.66 to 2.33 per cent., and the latter is equivalent to 74 pounds per ton on the draw-bar. One hundred horse-power minutes are thus gained at each stop and at each start.

The electric locomotives were supplied by the General Electric Co., the converters by the Thompson-Houston Co., the electric 'lifts' at the stations, dropping the passenger 60 to 90 feet at the start and raising him to the surface at his destination, were furnished by the Sprague Electric Co. The tunnel is double-barreled, each tube being 11 feet 6 inches in diameter. There are 13 stations and the running speed ranges from 14 to a maximum of 25 miles an hour between stations. Twenty-eight locomotives are employed; each hauling a train of seven carriages, conveying at most 336 passengers, the train weighing, empty, 105 tons, exclusive of the locomotive. The latter weighs about 50 short tons. Power is supplied also by an American firm, the E. P. Allis Co., who furnish six cross-compound engines, designed by Reynolds, of 1,300 to 1,900 horse-power each, and these are supplied with steam by 16 Babcock & Wilcox water-tube boilers—another American invention. The generators are three-phase, alternating current, with revolving fields. The armatures weigh 48,000 pounds. The output is 850 kilowatts, each, at 5,000 volts, 25 periods per second. Four six-pole exciters, driven, each, by a compound engine at 450 r. p. m., direct, supply to each generator 50 kilowatts at 125 volts. The switchboard is of marble. There are 19 miles of cable, weighing 78.4 tons. The engineers of the line are Messrs. Benjamin Baker and Basil Mott.

R. H. Thurston.

* Treatise on 'Railway Improvements,' by R. Badnall; London, Sherwood, Gilbert and Piper, 1833.

WIRELESS TELEGRAPHY.

Professor J. A. Fleming writes to the London *Times* the following letter on recent advances in wireless telegraphy:

As the subject of wireless telegraphy has not yet apparently lost interest for the general reader, I venture to ask a little space to make known for the first time some recent achievements by Mr. Marconi which have astonished those who have been allowed to examine them. Every one is aware that in his system of electric wave telegraphy an important feature is the employment of an elevated conductor, which generally takes the form of a wire suspended from a mast. When Mr. Marconi attracted attention by his feat of establishing communication across the Channel without wires, critics raised a not altogether valid argument against its commercial utility, that a wave or signal sent out from one transmitter would affect equally all receivers within its sphere of influence and hence the privacy of the communication would be destroyed. No one felt the force of this objection more strongly than the distinguished inventor himself, whose original work has caused so many others to attempt to follow in his steps. For the last two years he has not ceased to grapple with the problem of isolating the lines of communication, and success has now rewarded his skill and industry. Technical details must be left to be described by him later on, but meanwhile I may say that he has modified his receiving and transmitting appliances so that they will only respond to each other when properly tuned to sympathy. I am well aware that other inventors have claimed to be able to do the same thing, but I do not fear refutation in saying that no one has given practical proof of possessing a solution of this problem which for a moment can compare with that Mr. Marconi is now in a position to furnish.

These experiments have been conducted between two stations 30 miles apart, one near Poole in Dorset and the other near St. Catharine's in the Isle of Wight. At the present

moment there are established at these places Mr. Marconi's latest appliances, so adjusted that each receiver at one station responds only to its corresponding transmitter at the other. During a three days' visit to Poole, Mr. Marconi invited me to apply any test I pleased to satisfy myself of the complete independence of the circuits, and the following are two out of many such tests: Two operators at St. Catharine's were instructed to send simultaneously two different wireless messages to Poole, and without delay or mistake the two were correctly recorded and printed down at the same time in Morse signals on the tapes of the two corresponding receivers at Poole.

In this first demonstration each receiver was connected to its own independent aërial wire hung from the same mast. But greater wonders followed. Mr. Marconi placed the receivers at Poole one on the top of the other, and connected them both to one and the same wire about 40 ft. in length, attached to a mast. I then asked to have two messages sent at the same moment by the operators at St. Catherine's, one in English and one in French. Without failure each receiver at Poole rolled out its paper tape, the message in English perfect on one and that in French on the other. When it is realized that these visible dots and dashes are the results of trains of intermingled electric waves rushing with the speed of light across the intervening 30 miles, caught on one and the same short aërial wire and disentangled and sorted out automatically by the two machines into intelligible messages in different languages, the wonder of it all cannot but strike the mind.

Your space is too valuable to be encroached upon by further details, or else I might mention some marvellous results, exhibited by Mr. Marconi during the same demonstrations, of messages received from a transmitter 30 miles away and recorded by an instrument in a closed room merely by the aid of a zinc cylinder, four feet high, placed on a chair. More surprising is it to learn that, whilst these experiments have been proceeding between Poole and St. Catherine's, others have been taking place for the Admiralty between Portsmouth and Portland, these lines of communication intersecting each other; yet so perfect is the independence that nothing done on one circuit now affects the other, unless desired. A corollary of these latest improvements is that the necessity for very high masts is abolished. Mr. Marconi now has established perfect independent wireless telegraphic communication between Poole and St. Catherine's, a distance of 30 miles, by means of a pair of metal cylinders elevated 25 or 30 feet above the ground at each place.

I need not enlarge on the possibilities thus opened out for naval and military purposes. The importance of this practical solution of the problem of independent electric wave telegraphy, in which each wireless circuit is as private as one with a wire, is obvious without comment. My desire is solely to mention the above facts for the benefit of general readers, whose minds will thus perhaps be eased of any doubts lest this brilliant application of electrical discoveries should, like some others, fall short of satisfying the requirements of practical use and be relegated to the region of imperfect inventions or unfulfilled hopes.

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*SPECIES OF MOSQUITOES COLLECTED FOR THE BRITISH MUSEUM.**

AT the latter end of 1898 a committee was appointed jointly by Mr. Chamberlain and the Royal Society to exercise a general supervision over a scientific investigation of malaria, and it was then suggested that, in view of the connection of malaria with mosquitoes, it would be desirable to obtain exact knowledge of the different species of mosquitoes and allied insects in the various tropical colonies. Acting on this suggestion, Mr. Chamberlain at once issued a circular despatch to the Governors of all the Crown colonies, requesting them to take the necessary steps to have such collections made and sent to the Natural History Museum for examination and classification of the specimens. For the guidance of those who might be employed on the work, directions for collecting, mounting and preserving the insects were drawn up by the museum and distributed in the colonies. As a result of these measures considerably over 3,000 specimens of mosquitoes have, we learn, been received at Cromwell-road up to

* From the London *Times*.

the present from various quarters, and collections are still coming in almost every week. The work of identifying and describing the specimens was at first entrusted to Mr. E. E. Austen, the dipterist on the staff of the museum, but later he volunteered for active service in South Africa and joined the City Imperial Volunteers. Apart from his duties as a soldier Mr. Austen has, we hear, done useful service in his capacity of naturalist in the South African Field Force. There are not many professional dipterists in this country, and it was therefore fortunate that the director of the museum, Professor Ray Lankester, was able to obtain the services of Mr. F. V. Theobald, a graduate of the University of Cambridge, who is one of the few men in England who has studied mosquitoes, to carry on the work in Mr. Austen's absence. Mr. Theobald is now engaged in the preparation of a monograph on mosquitoes, based on the collections at the museum, the printing of which has been sanctioned by the trustees.

Pending the issue of this catalogue, it has been thought desirable, for the satisfaction of those who have been at the trouble to make the collections, to print a preliminary report of the progress made by Mr. Theobald in identifying the specimens already received. The combined collections contain a large number of species, the majority belonging to the genus *Culex*. Mr. Theobald at present has completed the genus *Anopheles*, which has been hopelessly convicted of being the medium by which the malaria parasite is transmitted from person to person. The genus is represented in the museum by 22 species, 10 of which are new to science. The *Anopheles*, unlike the comparatively inocuous *Culex*, does not appear to have a wide distribution in regard to species, although the genus is world-wide. One of the greatest distances between any two localities for the same species is Formosa and the Straits Settlements. A long series sent by Mr. Wray from the Straits Settlements contained 66 *Anopheles* and 72 *Culex*, the former being remarkable for their great variation both in color and in size; whereas all the other specimens of the genus received appear very constant in color and markings. Some species of *Culex* seem to have a very wide distribution. Thus one species has been sent from the following widely-separated localities: Japan, Formosa, Hong-kong, Malay Peninsula, India, South and West Africa, North and South America, West Indies and Gibralter. As many of the species are very obscure, photographs of the wings and drawings of various parts are being prepared, and complete figures of the majority of species will also be given in the proposed monograph. The collection and preservation of these tiny and very delicate insects are a most difficult matter, involving unwearied patience and extreme care. The fact that most of the collections have arrived at the museum from remote parts of the world in fair condition says much for the zeal and care with which the gentlemen concerned have endeavored to carry out the wishes of the Colonial Secretary in this important investigation.

YELLOW FEVER AND MOSQUITOES.

A PRELIMINARY paper on the etiology of yellow fever, by Walter Reed, surgeon, United States army, and James Carroll, A. Agramonte, Jesse W. Lazear, assistant surgeons, United States army, was read at the recent meeting of the American Public Health Association at Indianapolis and is published in the last issue of the *Philadelphia Medical Journal*. It appears that in eleven cases in which non-immune individuals were inoculated through the bites of mosquitoes (*culex fasciatus*) two attacks of yellow fever followed and that another attack is directly traced to the bite of a contaminated mosquito. The authors conclude as follows:

For ourselves, we have been profoundly impressed with the mode of infection and with the results that followed the bite of the mosquito in these three cases. Our results would appear to throw new light on Carter's observations in Mississippi, as to the period required between the introduction of the first (infecting) case and the occurrence of secondary cases of yellow fever.

Since we here, for the first time, record a case in which a typical attack of yellow fever has followed the bite of an infected mosquito, within the usual period of incubation of the disease, and in which other sources of infection can be

excluded, we feel confident that the publication of these observations must excite renewed interest in the mosquito-theory of the propagation of yellow fever, as first proposed by Finlay.

From the first part of our study of yellow fever, we draw the following conclusions:

1. The blood taken during life from the general venous circulation, on various days of the disease, in 18 cases of yellow fever, successively studied, has given negative results as regards the presence of *B. icteroides*.

2. Cultures taken from the blood and organs of 11 yellow fever cadavers have also proved negative as regards the presence of this bacillus.

3. *Bacillus icteroides* (*Sanarelli*) stands in no causative relation to yellow fever, but, when present, should be considered as a secondary invader in this disease.

From the second part of our study of yellow fever, we draw the following conclusions:

The mosquito serves as the intermediate host for the parasite of yellow fever, and it is highly probable that the disease is only propagated through the bite of this insect.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR S. P. LANGLEY, director of the Smithsonian Institution returned to the United States on October 24th. He was given the honorary degree of Doctor of Science on October 11th, by Cambridge University.

THE Rumford Committee of the American Academy of Arts and Sciences has voted a grant of $200 to Mr. C. E. Mendenhall of Williams College for the furtherance of his investigations on a hollow bolometer, and a grant of $500 to Professor George E. Hale of the Yerkes Observatory in furtherance of his researches in connection with the application of the radiometer and a study of the infra-red spectrum of the chromosphere.

DR. E. W. HOBSON, F.R.S., has been nominated for the presidency of the London Mathematical Society, succeeding Lord Kelvin.

SIR LOWTHIAN BELL, F.R.S., succeeds the Hon. C. A. Parsons, F.R.S. as president of the British Institution of Junior Engineers.

PROFESSOR BRUHNES, who holds the chair of physics in the University of Dijon, has been appointed director of the observatory on the Puide-Dôme.

MR. MARSHALL H. SAVILLE, of the American Museum of Natural History, left for Southern Mexico on November 1st, where he will continue his excavations in the territory formerly occupied by the Zapotecans.

DR. KARL E. GUTHE, of the department of physics of the University of Michigan, is spending the present year in Leipzic, Germany, conducting investigations in the general subject of physical chemistry.

A BRONZE medallion with a likeness of Sylvester will hereafter be awarded as a mathematical prize at the Johns Hopkins University.

THE death is announced, at the age of seventy-seven years, of Dr. Friedrich Max-Müller, Corpus professor of comparative philology at Oxford University, well-known throughout the world for his researches in oriental philosophy and literature and for his more popular writings, covering a wide field.

DR. MOSES C. WHITE, emeritus professor in the Yale Medical School, died on October 24th aged seventy-nine years, and Dr. Lawrence Turnbull, the author of numerous works on diseases of the eye and ear, and a well-known specialist, on October 24th, aged seventy-nine years.

WE regret also to record the death at the age of sixty-one years of Dr. A. B. Frank, professor of botany in the Agricultural School at Berlin and director of the biological division of the Imperial Board of Health; of Dr. Robert Hegler, docent in chemistry in the University at Rostock, on September 29th, aged thirty-one years, and of Dr. Ferdinand Anton, director of the astronomical and meteorological observatory of Trieste, on October 3d, at the age of fifty-six years.

WE have already called attention to the appointment of a Baird Memorial Committee, of which Dr. H. M. Smith is chairman, the object of which is to erect a tablet or monument at Woods Holl in memory of the late Spencer F. Baird. The nature of the proposed memorial has not yet been determined as it must depend on the amount subscribed, but the committee

are now prepared to receive subscriptions. Any contribution will be acceptable, but the committee are especially anxious to receive a large number of small individual subscriptions. These may be sent to the treasurer of the committee, the Hon. E. G. Blackford, Fulton Market, New York City.

The Eighteenth Congress of the American Ornithologists' Union will convene in Cambridge, Mass., on Monday, November 12th at 8 o'clock P. M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings, open to the public and devoted to the reading and discussion of scientific papers, will be held in the Nash Lecture room, University Museum, Oxford St., beginning Tuesday, November 13th, at 10 A. M., and continuing for three days.

The Trustees of the Carnegie Institute, Pittsburg, have sent invitations for the celebration of Founders Day in Music Hall and for an exhibition of the Art Gallery, Library and Museum on Thursday afternoon, November 1st. The Museum has been greatly enriched during the present year by the fossil vertebrates of Wyoming and South Dakota, which will be described by Dr. J. B. Hatcher in the next issue of this Journal.

The lecture arrangements of the London Institution for the present season include the following: 'The Rise of Egyptian Civilization,' by Professor Flinders Petrie; 'The Earth's Beginning,' by Sir Robert Ball; 'The Earth's Earliest Inhabitants,' by Professor Grenville Cole; 'The Caves of Jenolan,' by Mr. F. Lambert; 'The Tercentenary of the Science of Electricity,' by Professor Sylvanus Thompson; 'The Evolution of the Brain,' by Dr. Alex Hill; 'Modern Aeronautics,' by Mr. Eric S. Bruce; 'The First Ascent of Mount Kenya,' by Mr. H. J. MacKinder; 'The Effect of Alcohol on the Nervous System,' by Professor Victor Horsley; 'The Decorative Art of Primitive Peoples,' by Professor A. C. Haddon, and 'Aquatic Autocrats and Fairies,' by Mr. F. Enock.

A civil service examination will be held on November 20th to fill the position of assistant biologist in the Division of Biological Survey, Department of Agriculture, at an annual salary of $1,500. The subjects and their weights are as follows: Essay writing, 1; French, 1; German, 1; physical geography of the United States, 1; ornithology and mammalogy, 3; identification of specimens, 3.

According to the St. Petersburg *Gazette*, the Russian Government has decided to adopt the metric standard of weights and measures, and the ministry of finance is now engaged in considering the time and manner of introducing this reform.

The expedition sent by the Harvard Observatory to observe the planet Eros in its approaching opposition has arrived at Kingston, Jamaica, and is being afforded facilities for its work by the Government.

A cable dispatch to the New York *Sun* states that an official report of the Duke of the Abruzzi's discoveries in the north is published in the *Rivista Maritima*. It says the expedition corrected the position of Cape Flora, and reports that King Oscar Island and Petermann Land do not exist.

A pathological institute is being built at Quala Lumpoy, the capital of the federated Malay States, and Dr. Hamilton Wright has been appointed director. The British Colonial Office has offered to pay the expenses of students who wish to study beri-beri and malaria at the new institute.

Vice-Consul General Hanauer, of Frankfort, under date of September 29, 1900, says: Molten wood is a new invention by Mr. De Gall, inspector of forests at Lemur, France. By means of dry distillation and high pressure, the escape of developing gases is prevented, thereby reducing the wood to a molten condition. After cooling off, the mass assumes the character of coal, yet without showing a trace of the organic structure of that mineral. This new body is hard, but can be shaped and polished at will; is impervious to water and acids, and is a perfect electrical non-conductor.

The London *Times* states, that a meeting of the British and American members of the International Association for the Advancement of Science, Arts and Education was held in the

United States pavilion at the exhibition on September 14th. Mr. Bryce, M.P., vice-president of the British group, was in the chair. The officials and various members of the French, Russian, and German groups of the Association were also present. A report prepared by the secretaries of the work of the first year was read by Professor Patrick Geddes. He described the work in Paris, which has been to provide, on the one hand, a rendezvous and center for scientific men and others attending the congresses of the exhibition; and, on the other, to provide for the public interested in various sections expert guidance to these. He further stated that a series of brief reports were being prepared by members of the assembly on special phases of the exhibition, and that it was proposed to organize assemblies at the Glasgow Exhibition of 1901 and the St. Louis Exhibition of 1903. Resolutions commending the work of the Association in all its branches and approving the proposals for future activities were proposed and carried unanimously. The chairman, in supporting the resolutions, said that he hoped all present would endeavor to bring the aims of the organization to the knowledge of those who would be able to give it financial help. He wished to dwell for a moment on the excellent evidence of international cooperation which was to be seen in this Association. Lately there had been a meeting of Chambers of Commerce in Paris, and much had been said of the advantages to be gained from peace and harmony among the nations. But commerce, much as they desired it to be means of peace, sometimes led to strife. He thought there was something which made far more strongly for peace, and that was science and learning, which did not depend for their growth on competition and rivalry. For this reason he felt that their association should be a great factor towards international understanding. He felt the exhibition had made an opportunity for the coming together of the *savants* of the world, and the International Association gave the means to continue the friendly relations there begun.

A REPORT on the plague in Egypt, covering the period from May, 1899, to July, 1900, which has been issued from the Sanitary Department of the Ministry of the Interior at Cairo, according to the London *Times*, contains a very full and clear account of the outbreak at Alexandria which commenced in the first named month, and the last case of which occurred on the 5th of the following November. In all 96 cases became known to the authorities; and it was estimated that 27 more, of mild character and followed by recovery, might possibly have escaped notification. The 96 were made up of 66 natives and 30 foreigners, the latter mostly Greeks, Frenchmen or Italians employed in groceries, bakeries, wine shops or at restaurateurs. The mortality among reported cases was 48 per cent., and there was reason to believe that no death from plague escaped notice. The precautions taken for arresting the course of the disease appear to have been admirably devised and conducted, and are set forth under the three heads of—(1) measures to assure prompt discovery of each case of plague and of all suspicious cases; (2) direct measures to prevent the propagation of the disease from individual cases; and (3) indirect measures, such as general cleansing of dirty quarters, with a view to eliminate all conditions favorable to the existence or propagation of the disease. A sum of £E.30,000 was granted by the Caisse de la Dette to defray the extra expenses, and was placed at the disposal of the Director-General of the Sanitary Department; but the total outlay exceeded this sum by £E.4000; and the whole of the work required seems to have been carried out with great discretion and tact, and with the *minimum* of offence to religious or other susceptibilities. The description of the administration, which is in English, is followed by a report in French on the clinical histories of the more important cases, a history from which it appears that, without bacteriological examination, the diagnosis of plague is beset by great difficulties and must often be extremely uncertain.

UNIVERSITY AND EDUCATIONAL NEWS.

THE daily papers report that a trustee of Beloit College has offered to contribute $200,000 in case the further sum of $150,000 is collected for the College.

MR. HOLBROOK GASKELL has given $5,000

towards a new physical laboratory for University College, Liverpool. It appears from the report of the treasurer of the College that there was last year a deficit of $6,000 and that the debt of the College is $55,000.

THE Oxford City Council has secured a new valuation of the property of the University and the Colleges which would subject them to an increased tax of $23,000 a year. The question of increased valuation will probably come before the Courts.

ACCORDING to the daily papers Lafayette College conferred on October 24th, an honorary Ph.D. degree on the Rev. Ernest P. F. Pfattecher of Lebanon. If this news is correct the Association of Colleges and Preparatory Schools of the Middle States and Maryland should at its approaching meeting take action that will prevent the improper use of this degree.

THE registration at Harvard University is as follows: in the college, senior class, 391; junior class, 379; sophomore, 539; freshman, 537; special students, 149; total in college, 1,995, a gain of 99 over last year; the scientific school, 506, a gain of 12; graduate school, 327, a gain of 12; divinity school, 25, a loss of 2; law school, 618, a gain of 14; medical school, 590, a gain of 40; dental school, 129, a loss of 3; veterinary school, 17, a loss of 7; Bussey institution, 27, a gain of 2; total for the academic year 1900, 4,234; total gain, 167.

THE enrollment of undergraduates at Princeton University shows a total gain of 120 compared with the figures of last year. There are 745 academic students, an increase of fifty-nine, and 421 in the scientific department, a gain of fifty-eight. Seven men are registered in the electrical school, against four last year.

AT Williams College Dr. F. H. Howard, of the College of Physicians and Surgeons of New York, has been appointed instructor in physiology and hygiene in place of Dr. Woodbridge, who died a year ago.

THE income of the Stearns' Fellowship in the pharmaceutical department of the University of Michigan for the present and sixth year has been divided between Harold C. Watkins and Charles R. Eckler, who are at work in parallel lines upon the same subject, namely, the chemical and botanical characteristics of certain plants of the poppy family. Mr. Watkins will investigate the chemistry, Mr. Eckler the botanical characteristics of the plants. The work is under the supervision of Professor Julius O. Schlotterbeck.

SIR H. E. ROSCOE, F.R.S., is vice-chancellor of the reorganized University of London, and Sir John Wolfe Wolfe-Barry, F.R.S., is one of the crown members of the senate. The faculty members representing science are Sir Michael Foster, Sec. F.R.S., Dr. William B. Halliburton, F.R.S., Professor William Ramsay, F.R.S., and Professor A. W. Rücker, F.R.S. The representatives of the different institutions in the senate also include a number of scientific men —Lord Lister, Professor G. C. Foster, Dr. P. H. Pye-Smith and others.

PROFESSOR T. G. BONNEY, F.R.S., has resigned from the chair of geology in University College, London, which he has held for thirty-three years.

THE Committee of the School of Geography, at Oxford University, has elected the Rev. Edward Clarke Spicer, of New College, to the Geographical Scholarship for 1900–1901.

DR. HANS GEORGES, engineer-in-chief of the firm of Siemens & Halske, has been appointed director of the Electrical Engineering Institute and professor of electrical engineering in the Dresden Institute of Technology.

DR. LORENZ, of the University at Halle, has been made director of the Physical and Technological Institute of the University at Göttingen.

DR. M. VON RACIBORSKI has been appointed professor of botany and director of the botanical gardens in the agricultural school at Dublaney, near Lemberg.

DR. FRANZ KOLACEK, of the Bohemian University at Prague, has been appointed professor of physics in the School of Technology at Brünn, and Dr. Sauer of Heidelberg professor of mineralogy and geology in the Polytechnic Institute at Stuttgart. Dr. Emil Borras of the Geodetic Institute at Pottsdam has been promoted to a professorship.